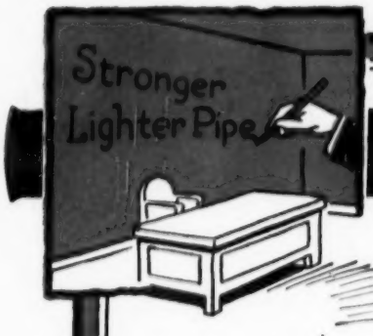
# PUBLIC WORKS

CITY COUNTY STATE






McWane Cast Iron Pipe

## The Hand-Writing On The Wall.

CONSUMPTION of modern type cast iron pipe (stronger but lighter) for over a year now has exceeded the use of old style heavy pipe.

*McWane precalked joints are a privilege—not a necessity. For the man "who pours his own," we make the same sturdy bell-and-spigot pipe minus the joint materials (open bell). Either way, you get the same McWane pipe—brute strength without brute weight, standard lengths and a lower joint cost.*

**McWane pipe is the only modern improved type in 16-foot lengths that is moulded *horizontally* in *green sand*, both "inside and outside"—with molten iron flowing *inches* instead of *feet**.**

**McWane Pipe cuts well, taps well and ships well.**

*The shorter distance iron flows, the stronger and sounder the casting. Nature penalizes long distance casting.

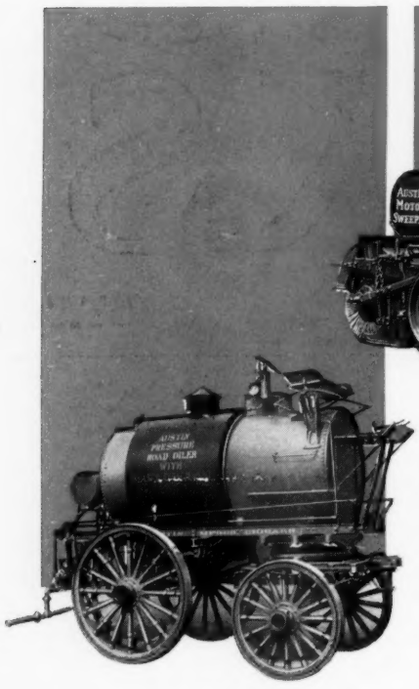
WRITE FOR ILLUSTRATED LITERATURE

McWANE CAST IRON PIPE CO. BIRMINGHAM, ALA. PACIFIC STATES CAST IRON PIPE CO. PROVO, UTAH.

SALES OFFICES IN PRINCIPAL CITIES

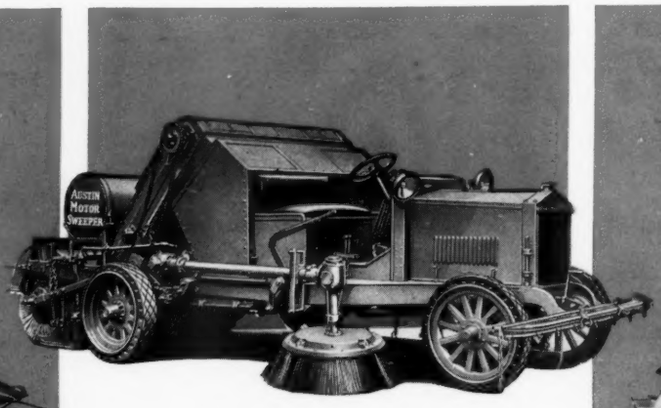
McWANE CAST IRON PIPE

THE AUSTIN-WESTERN LINE



**Horse-Drawn Pressure Road Oiler**

The Austin Horse-Drawn Pressure Road Oiler has a tank capacity of 600 gallons. The construction throughout is the most rigid possible, to carry the heavy strain of a full tank of oil. We can also furnish oiler units for mounting on trucks, or complete trailer oilers for pulling behind trucks or tractors. All models are supplied with or without heater attachments.




**The Motor Pick-Up Sweeper**

The Austin Motor Pick-Up Sweeper is the reliable 4-wheel chassis type. The two-speed oscillating gutter broom scours the gutter clean and places the dirt in the direct path of the pick-up broom. An absolutely clean pick-up of all sweepings is assured by the squeegee beltless conveyor. There is also the Austin Horse-Drawn Sweeper as well as the Two-Speed Sprinkler Sweeper which does away with the need of operating a sprinkler ahead of a sweeper.

**Horse-Drawn Street Sprinkler**

Austin Horse-Drawn Sprinklers are made in 450 and 600 gallon capacities. Vertical, perforated spray heads or valves that can be instantly adjusted for light or heavy spray are standard equipment. A light, sturdy frame and a patented oscillating fifth wheel protect the tank from wrenching or twisting, and insure smooth operation. We also furnish sprinkler units for mounting on motor trucks. Made in 450, 600, 750 and 1000 gallon capacities.

1858

# Quality *that* Survives–

1928

**Austin-Western offers you, not only the leading line of street repair and upkeep machinery, but the security that always is yours when doing business with the leaders in *any* industry. Our horse-drawn sprinklers and sweepers are the oldest on the market today. We also put out the first successful horse-drawn pressure road oiler. This ability to survive is proof of inbuilt quality and is typical of all Austin-Western products.**

THE AUSTIN - WESTERN ROAD MACHINERY CO.

400 North Michigan Ave., Chicago, Ill.

Branches in Principal Cities

# Austin-Western
## ROAD MACHINERY

"MOST MILES FOR YOUR ROAD DOLLARS"


VOL. 59 NO. 6

Entered as second-class matter at the Post Office, at New York, N. Y., Sept. 1, 1922, under the Act of March 3, 1879.
Published monthly by PUBLIC WORKS JOURNAL CORPORATION, 243 West 39th Street, New York, N. Y.
Subscription price $3.00 a year. Single copies 35 cents.

# PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 59 June, 1928 No. 6


# The Mokelumne Water Project

**Nine California communities, operating as a district, to obtain water through a ninety-four-mile conduit, including eighty-one miles of welded pipe. Special provisions against breakage. Unusually large rolled earth embankment.**

The water problem is one of the most important which citizens of California have to solve. Not only is it necessary for municipal use, as in the east, but over a large part of the state irrigation is essential for raising fruit and other crops.

And water is not abundant near the coast. Los Angeles has gone 235 miles into the mountains for it, and San Francisco 156 miles. The latter supply—the Hetch Hetchy—is not yet available in the city, but on May 1st San Francisco voted by a large majority to issue $65,000,000 in bonds, $24,000,000 to complete the aqueduct system, and $41,000,000 for the purchase of the water properties of the Spring Valley Company, which now supply water to the city.

Another system now under construction in the state is of interest, not because of its magnitude, but because it is being constructed jointly by nine communities; and these, with only about 450,000 population, are going 94 miles for water and spending $65,000,000. This is the Mokelumne project of the East Bay Municipal Utility District.

This dictrict was founded under the California "Municipal Utility District Act" of 1921. It comprises Oakland, Berkeley, Alameda, Richmond, San Leandro, Piedmont, Albany, Emeryville, and El Cerrito, all on the eastern side of San Francisco Bay, opposite San Francisco. This district voted $39,000,000 in bonds in November, 1924, for constructing the sytem; and on November 1st, 1927, voted $26,000,000 for constructing local distribution systems or acquiring the existing systems, whichever the five directors of the district may decide to be to its best interests.

## RESERVOIRS

*Pardee Reservoir.*—The supply is to be obtained from Mokelumne river, where a dam, known as Lancha Plana dam, will create Pardee reservoir, the primary storage reservoir of the project, with a watershed of 368,000 acres, and storage for 72,394 million gallons. Another reservoir, Lafayette reservoir, with a watershed of 915 acres and 3,875 million gallons storage, will serve as an equalizing reservoir, for emergency storage, and as a by-pass for water into upper San Leandro reservoir, a distribution reservoir.

Another distribution reservoir known as Rockridge reservoir, capacity 23.8 million gallons, located

CONSTRUCTING LAFAYETTE DAM

A rolled earth fill dam with clay core containing about 1,900,000 cubic yards of earth. Crest length, 1,855 feet. Maximum height 170 feet. Reservoir capacity, 3,875 million gallons.

in Oakland, will serve as an equalizing and balancing reservoir for the distribution system in the central and southern parts of the district.

Two other reservoirs are planned, Wildcat, as an equalizing storage reservoir for the distribution system in the northern part of the district; and Sequoia, 73 million gallons storage, in the southeastern part of Oakland.

Pardee reservoir will have its maximum storage surface at elevation 567.5, with the outlet tunnel at elevation 392, the available storage between these two elevations being 66,473 million gallons. The area flooded is 2,134 acres.

Lancha Plana dam is a curved gravity concrete dam, 345 feet high above the river bed, containing 600,000 cubic yards of concrete. All materials have to be transported over five miles of standard gauge railroad built by the contractors.

Down stream from this dam is a power house containing two 7,500 k. w. generators.

At the end of the north arm of the reservoir, on the divide between Mokelumne river and Dry creek, is a spillway to allow diversion (as required by the State Division of Water Rights) of excess flood waters of the Mokelumne river to Dry creek, where it may be stored by other parties for irrigation uses in the lower Mokelumne river area. This is a siphon spillway with a capacity of 16,000 second feet.

Another, the South spillway, dams a low saddle directly south of the dam and will release excess floods from the reservoir. It is a combination weir and siphon spillway, with crest elevation varying from 567.5 to 572.5. When the water in the reservoir reaches elevation 575, the capacity of the spillway is approximately 50,000 second-feet.

Lancha Plana dam is about one-fifth completed.

*Lafayette reservoir* has a maximum storage surface elevation of 500.0. The dam is of rolled earth, with a clay core wall; the embankment below the wall being porous, with subdrains, while that above it is of materials selected for watertightness. The upstream face will be paved with 6-inch concrete slabs on 8 inches of gravel. The down stream slope will be sodded. The up-stream slope will be 3 to 1, the down stream 2½ to 1.

The dam will have a maximum height of 170 feet, and the crest will be 1,885 feet long and 30 feet wide. There will be about 400,000 cubic yards of clay and 1,500,000 cubic yards of other earth in the embankment. The concrete will total 12,600 cubic yards, with 800,000 pounds of reinforcing steel.

The layers of earth are sprinkled for rolling by means of lines of 2-inch pipe supported by A frames, drawing water from a 50,000-gallon tank located on the hill above the dam, which is filled by an electrically operated pump.

The A frames also support electric lights to permit night work.

*Rockridge reservoir* is in two parts, with water elevations of 330 and 305 respectively; the upper holding 5,083,400 gallons and the lower 18,741,700 gallons. They are formed by the construction of two reinforced concrete Ambursen type dams, 40 and 45 feet high respectively. They will be lined with concrete, completely enclosed with a reinforced concrete wall, and covered with an asbestos shingle roof supported on reinforced concrete columns.

*Sequoia reservoir* requires two dams, one reinforced concrete multiple-arch, 70 feet high; the other a rolled earth dam 75 feet high with puddled earth core.

### THE CONDUIT

Leaving Pardee reservoir, the water will flow through Lancha Plana tunnel, 11,659 feet long, 8-foot horseshoe section—a concrete-lined pressure tunnel sustaining a maximum head of 167.5 feet. At the outlet of the tunnel will be a venturi meter and a 65-inch balanced throttle valve. The meter will be read and the valve operated at the power house more than two miles away.

From here a pipe line runs in a nearly straight line for 37 miles southwesterly to Holt, beyond which it parallels the right of way of the Santa Fe railroad for 11 miles westerly; then travels in a generally northwesterly direction 24 miles; then 10½ miles in a direct southwesterly line to the Walnut creek tunnel—8-foot, horseshoe shaped, concrete lined.

Passing through this tunnel, 2,122 feet long, and a 9-foot concrete aqueduct 18,694 feet long, the water reaches the Lafayette tunnel, 16,136 feet long, immediately followed by the Claremont tunnel, 18,004 feet long. Between these two tunnels is the Orinda gate house at San Pablo creek, where excess water from Mokalumne river can discharge through flap gates into the creek, as the use of water in the district fluctuates. Water so discharged will flow down the creek to San Pablo reservoir, whence it may be conveyed to the district, as needed, by way of the Albany filtration plant.

The Lafayette tunnel is 8 feet in diameter, the Claremont 9 feet; both concrete lined.

The outlet of Claremont tunnel is in Oakland. Here will be located the Claremont cistern, with control valves for the Rockridge siphon and Sequoia aqueduct, giving complete control of the flow in the distribution mains. Here water which is not needed can be backed up into Claremont tunnel, which will store about 9,000,000 gallons.

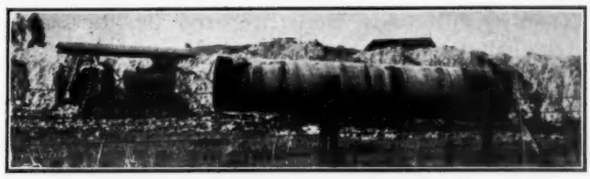
From here the water will flow through three parallel 54-inch pipe lines, each with a venturi meter, one turning north known as Wildcat aqueduct, the other two forming Rockridge siphon across Temescal creek and discharging into Rockridge reservoir. The Wildcat aqueduct continues north for 54,482 feet, to provide a high line aqueduct for distributing water in the north end of the district.

Of the 81 miles of pipe, 10.22 miles is on piling, 2926 feet is in double-line submerged river crossings, and the balance is laid in trench.

At Walnut creek a booster pumping plant has been located, to increase the capacity of the pipe line when necessary. It comprises two 24 x 24 two-stage centrifugal pumps, direct connected to 1,600 h. p., 600 r. p. m., 2,300-volt, 3-phase, 60-cycle synchronous motors; the capacity being 60,000,000 gallons a day.

An aeration weir is located at the inlet end of Walnut creek tunnel, to aerate the water, which will have been in a closed conduit for 82.5 miles.

At the Lafayette aqueduct is a screening chamber provided with ¼-inch mesh screens to remove any floating debris. There is provision here for a filtration plant also, although it is not anticipated that filtration will be necessary.



TRACTOR HAULING SECTION OF STEEL PIPE ON SLED THROUGH MARSHY LAND

METHOD OF OPERATION

The conduit may be operated wholly by gravity, or by gravity combined with booster pumping at Walnut creek. When by gravity alone, the line will deliver about 31,000,000 gallons at Walnut creek tunnel when the water surface of Pardee reservoir is at elevation 520; which will increase to 37,000,000 gallons when the reservoir reaches elevation 567.5. When the pumps are operating, the capacity will be increased to 60,000,000 gallons when Pardee reservoir is at elevation 520.

The steel pipe line is protected from collapse, which might result from a vacuum due to a break of the pipe, by vacuum relief valves at every major break in slope of the pipe, which will admit air into the pipe should a vacuum form.

As a protection against damage which might be caused by flood from a break if the pipe should completely empty at one point, four 24-inch automatic synchronous stop and relief valves have been provided at points where no damage would result from waste waters. These are adjusted to open whenever there may be a material increase in velocity of the water flowing past them.

WELDED PIPE LINE

The pipe line part of the aqueduct is constructed of electrically welded steel pipe 65 inches in diameter—believed to be the longest line of welded pipe as large as this. The longitudinal seams are electrically welded in the shop, and it was planned to weld the girth joints in the field by acetylene flame. After 68 of the field joints had broken, this was abandoned for riveting.

In laying, the 30-foot lengths of pipe were laid in the trench with ends in contact, the joints were welded from the outside with oxyacetylene flame, and backfill placed leaving the joints exposed for a pressure test, the joints being later reinforced by an electric arc weld made on the inside.

The ends of the pipe were beveled on the outside to a 90° V joint. During the day, when the joints were being made, the temperature of the pipe was 95° to 100° at the bottom and 140° to 160° at the top, but cooled at night to 65° to 70° at the bottom and 60° to 65° at the top. These changes of temperature set up stresses which varied widely between the top and the bottom of the pipe, and caused the breaks, which always occurred at night.

An investigation of these stresses and also those due to the heat of welding progressively around the pipe, of the creep of the pipe due to temperature changes, and the stresses which would be caused by low water temperature during operation, was made by Profs. L. T. Jones and W. S. Weeks, of the University of California, and embodied in an exhaustive report that has recently been published.

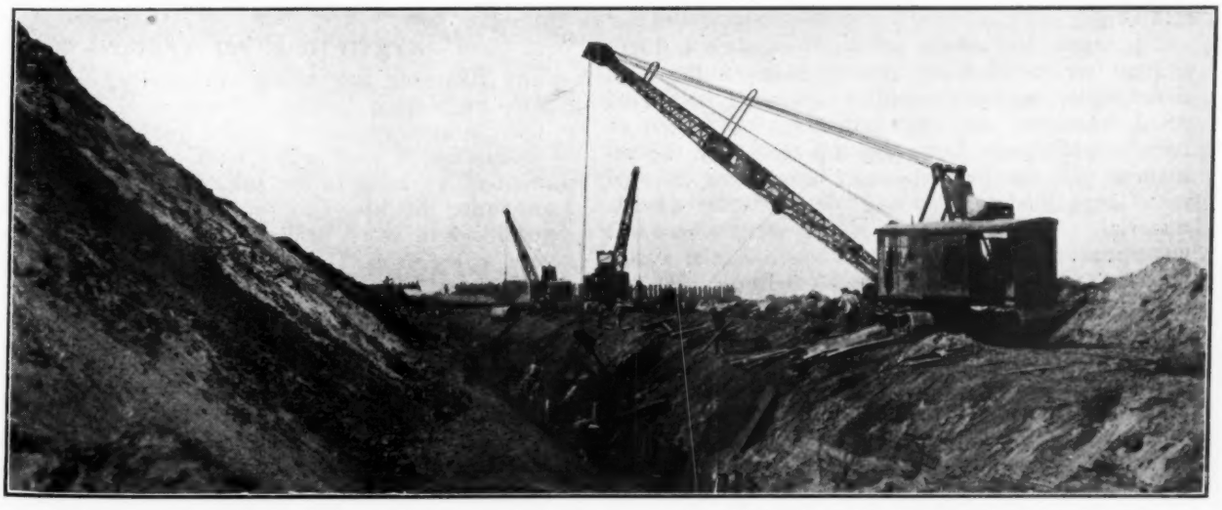
EMERGENCY CONSTRUCTION

Owing to right-of-way lawsuits, there has been delay in beginning work on the Lancha Plana reservoir and outlet tunnel. In order to obtain an emergency supply before the Mokelumna water is available, should this be necessary, it is planned to arrange to use water from the San Joaquin river, chlorinated. To permit this, work has been pushed on the western part of the conduit, and practically completed; this including the Lafayette and Walnut creek tunnels, the concrete conduit and 36.6 miles of steel pipe.

The chief engineer and general manager of the project is Arthur P. Davis, member of the American Water Works Association and Past President of the American Society of Civil Engineers.

## To Survey Los Angeles Water Supply

As one of the consequences of the failure of the St. Francis Dam, the Board of Water & Power Commissioners of the city of Los Angeles, Calif., has announced the selection and appointment of a board of engineers and geologists for making a survey of the whole Los Angeles water supply system. This will include a through in-



TRENCHING AND LAYING STEEL PIPE, MOKELUMNA AQUEDUCT

vestigation of the present dams, pipe lines, reservoirs, and other works.

The personnel of the Board includes Louis C. Hill of Los Angeles, a consulting engineer who has been retained in connection with the Roosevelt dam, Elephant's Butte dam, Gibraltar high arch dam and others; Robert T. Hill, consulting geologist, formerly professor of geology at the University of Texas and now professor of geology at the University of Southern California; and Robert E. McDonnell, consulting engineer with offices in Kansas City and Los Angeles, who has for thirty years specialized in hydraulic problems and whose firm has designed water works for something over 375 cities.

In addition to studying the present water works system of the city, the board will also consider the feasibility of their methods of storing water, such as storing large volumes either in or close to the city; storage for summer months, and locations that would be no menace to nearby communities.

## Lining Westerly's Concrete Standpipe

In his annual report for 1927 as superintendent of the Water Department of Westerly, R. I., Thomas McKenzie describes the re-lining of the concrete standpipe to prevent leakage.

This standpipe was built in 1910. It is 40 feet in diameter and 70 feet high, with a capacity of 650,000 gallons. The mixture used was about 1:1½:3, with 5 percent hydrated lime added for waterproofing. In filling, a leak developed. An effort was made to stop it by lining the tank with melted paraffine in the vicinity of the leak; then by lining with "plastic slate." These were not successful, but tightness was obtained (at a cost of 16½ cents a square foot) by applying a membrane of a specially prepared Neponset compound and five layers of waterproof felt on the interior walls. The application of this membrane secured the desired result at that time and the standpipe was tight. Within the last two years the pipe has leaked at the joints and the leakage increased to such an extent it was feared that the frost would damage the concrete and cause it to spall off exposing the steel reinforcing.

The water was drawn off on November 4, 1926, and an examination of the interior of the pipe showed that the waterproofing membrane had separated from the wall for a distance of fifteen or twenty feet down from the top and over the remainder of the pipe the membrane was covered with large blisters, showing deterioration of the material. On the bottom of the pipe, where the waterproofing was covered with concrete, the waterproofing material was in good condition. As the life of the material was gone, the work of cleaning the surface of the concrete and removing all of the old waterproofing material was commenced at once.

In the meantime, while this work was going on, a study was made of the problem and expert advice obtained for the best method of waterproofing the structure. After a thorough investigation it was decided to again apply the membrane method and protect the waterproof membrane from the action of the air and water with a four-inch brick lining. The specifications were prepared by the Hydrex Asphalt Products Corporation of New York.

As the work had to be done during the winter months and the waterproofing could not be applied on a cold surface, a portable steam boiler was set up outside the standpipe and steam coils built inside the pipe. Temperature records were kept both inside and outside the pipe during the progress of the work.

The inside surface of the pipe was thoroughly cleaned and scraped and one coat of Hydrex primer applied to the surface. After the primer had thoroughly set and dried, hot Hydrex compound was mopped on the surface of the wall to which was applied a coat of waterproof felt, and this process was followed up in successive layers of hot compound and felt until the surface was covered by four layers of felt and five layers of compound.

The work was commenced at the bottom of the tank and continued from a swinging stage, built around the interior wall and raised as the work progressed. Special care was taken around the manhole and inlet and outlet pipes, where heavy lead flashing was used in addition to the felt and compound.

Immediately following the application of the waterproof membrane, a four-inch brick core was constructed from the floor to the top of the wall. A one-half-inch annular space between the outside waterproof course and the inside face of the brick work was carefully filled with mortar. After completion of the brick work the walls were washed down with a cement and Celite wash. The floor was then covered with compound and felt and three inches of cement mortar.

The actual work of waterproofing continued from February 7th to March 9th, and laying brick lining from March 10th to April 9th; and water was turned on April 18th. No indications of seepage had appeared nine months later.

The surface covered was 1,094 square yards. The total cost $11,159, or $1.13 a square foot; of which the waterproofing cost 45 cents, the brick lining 51 cents, cleaning tank, erecting staging, etc., 11 cents, and the lead flashing heating, lighting and incidentals 6 cents.

## Oxygen in River Water

The following interesting experiments were described by Messrs. Butcher, Pentelow and Woodley in the *Biochemical Journal* of last year. The degree of saturation of river water with oxygen is an important criterion as to the suitability of a river for maintaining fish life. This property is one frequently determined in work dealing with the pollution of rivers, as the proportion of dissolved oxygen falls in the presence of oxidisable organic matter. It has recently been found, however, that there are both diurnal and seasonal variations in the proportions of dissolved oxygen and ammoniacal nitrogen in river waters. This has been established by making hourly determinations over periods of 24 hours both on a contaminated stream in Suffolk and on a pure and unpolluted Hampshire trout stream. The diurnal variations in the oxygen dissolved were greater in the case of the River Lark in Suffolk, although quite distinct in the pure River Itchem. The ammoniacal ni-

trogen, which varies in a sense opposite to that of the dissolved oxygen, also showed a diurnal variation in the Lark, but was constant in the Itchen. The variations, especially in dissolved oxygen, range in some cases from 60 per cent of saturation shortly after midnight, to 150 per cent shortly after midday. This diurnal change is explained as follows: The rise is attributed to the photochemical evolution of oxygen from organisms, and the fall to the absorption of this oxygen by organic matter, and by processes of respiration. It has thus become clear that in conducting a field survey of a river, a single determination of the dissolved oxygen is of little value. Investigations over a period of 24 hours are necessary, and consideration must be given to such factors as time of year, actinic conditions, nature of plant and animal life present, as well as to the character of the river bed and its history with regard to past pollution. It would be of interest to learn how far these changes influence the movement of fish.—*From "Water and Water Engineering," an English monthly.*

## Credit for Contractors

In the May issue, under the title of "Contractors' Obligations to the Construction Industry," we published an abstract of a paper read by S. M. Williams before the New York State Highway Chapter of the Associated General Contractors. After this had gone to press we received copies of a set of resolutions suggested by Mr. Williams for adoption by the various chapters of the A. G. C. and other contractors' organizations, which resolutions are as follows:

"WHEREAS many manufacturers and distributors of construction equipment are selling their products under credit terms which include small, if any, down payments and the payment of balances extending ever periods of many months, thus inducting into construction innumerable irresponsible concerns who demoralize the industry, and

WHEREAS these unduly extended credit terms have caused widespread over-expansion of construction companies, with consequent failures and defaults, which are injurious, not only to the interest of the public but also to the interests of all industries allied with construction, and

WHEREAS many outstanding equipment manufacturers and distributors recommend adherence to reasonable credit policies, including a substantial down payment, and the balance within the year or less; therefore,

BE IT RESOLVED BY THE (individual name or organization) that the national organization should endeavor through conference and co-operation with manufacturers and distributors to establish reasonable and standard credit policies in all parts of the country, and

BE IT RESOLVED that we shall encourage the members of the Associated General Contractors of America to submit to such reasonable standard credit policies for sale of machinery and equipment, and

BE IT FURTHER RESOLVED that in the purchase of machinery and equipment we shall favor those manufacturers and distributors who accept and definitely maintain such standard credit policies as may be adopted."

The national headquarters of the A. G. C. had already received the endorsement of the above resolutions by several of the chapters and are hoping that all of them will indorse them in the immediate future.

# Time Savers in Water Analysis

**The routine practice in the chemical laboratory of the Pennsylvania Department of Health**

**By Major F. E. Daniels***

Thirty-nine years of more or less constant experience connected with laboratories have enabled the writer to develop numerous schemes of manipulations and special apparatus designed to facilitate analytical procedure. The attempt has been to introduce time savers while at the same time adhering to standard pieces of apparatus where possible. Some of these were designed to permit satisfactory use of unsuitable apparatus inherited from another laboratory or of a room not designed for laboratory work.

By means of these procedures and apparatus we have developed a system whereby one person can put an ordinary sample of potable water through a sanitary chemical analysis of sixteen determinations, wash up and put away the apparatus in an hour and a quarter—a result well worth while, in our opinion. Our samples arrive by express in the afternoon, but the work of analysis is really begun at 9:00 A. M. the following day, and by noon the reports are on the way.

*Chief, Industrial Waste Section, Sanitary Water Board, and Director of the Chemical Laboratory

The following article is an attempt to describe in detail how this is accomplished.

### RECEIPT OF SAMPLE

The sample arrives in a half-gallon glass-stoppered bottle enclosed in a bass-wood box 7½ inches square and 14½ inches high, with spring corners of wood inside, reinforced with metal angle strips on the outside of the corners, a hinged lid with handle and catch on top, and a square piece of hair felt packing inside on the bottom. These boxes are made by F. C. White, Water Street, New York, and they are numbered for identification.

The box is opened, bottle taken out, muslin which has been tied on the top of the bottle removed, and a 2½-inch by 5-inch shipping tag is attached to the neck of the bottle, upon which tag the next consecutive laboratory number is written with a pencil, which number is at the same time placed upon the descriptive slip which was sent with the sample, as is also the number of the box for a record of its receipt.

Another bottle all ready to go out is taken from stock and placed in the box, and with it a waxed

envelop containing a blank descriptive slip and a shipping tag addressed to the laboratory. A supply of these made-up envelopes is kept on hand in a convenient drawer in the receiving table. The box is then closed and ready to go to the Division of Supplies, from which it is sent out on order.

### WALL RECORD BOARD

A wall record board is used upon which has been placed a long sheet of heavy wrapping paper, folded back and forth so as to make 144 pockets just 2¾ inches deep. A half-inch strip of wood over the folds down each side of the board and two evenly spaced between, form four columns of pockets which will take a 3″ x 5″ card in each and allow ¼ inch of the card to stick up, showing on the top of the card a number which corresponds to that on a water container box.

The pockets in each column are numbered from 1 to 144, as a gross of boxes are kept in commission; any new box taking the number of that replaced. The cards in the first column indicate the boxes on hand ready to go out; in the second column, the boxes in the Division of Supplies; and in the third column, the boxes shipped out for samples. (The fourth columns is not used).

When a sample is received, the card bearing the number of the box that contained it is taken from the third column. With a rubber dating stamp and pad kept on a convenient shelf beside the board, the date is stamped on the descriptive slip; also on the card to complete the record of the trip of this box, the card then showing the date (at the left) the box left the laboratory, the person and address to whom shipped (in the center), and the date it returned (on the right).

This card is now put over in the first column, indicating that the box has been made up and ready to go out again. When this box leaves the laboratory to go to the Division of Supplies, its card is dated and placed in the second column; and when it is shipped out, a report of such is sent to the laboratory and the names and addresses to whom shipped are entered upon the card, which is then placed in the third column of pockets. This system has worked admirably, and a glance at the board shows where each box is.

Form 600

**DESCRIPTION OF SAMPLE OF WATER FOR ANALYSIS**

Date of Collection

Municipality

Premises (Street No. and St. or Road)

Tenant of Premises

Owner of Premises

Sample taken from (Well, Spring, Stream, Reservoir, Cistern, Tap)

Collected by Weather Conditions for previous 24 hrs.

IF FROM TAP give name of Water Company and Source of Supply

IF FROM STREAM OR RESERVOIR give name

IF FROM WELL OR SPRING give (1) distance from Privy ft. Cesspool ft. House Drain ft. Barnyard ft.

Street Sewer ft. (2) Nature of Soil Well (Driven or Dug) (Depth) (Diameter) Spring is (Open, Covered)

(3) Describe Slope of Ground

Classification of Supply (Public, Private, etc.)

Purpose of Analysis

Special Tests Desired

(READ OTHER SIDE)

Form 601

**PENNSYLVANIA DEPARTMENT OF HEALTH**

**RECORD OF WATER ANALYSIS**

| | |
|---|---|
| SAMPLE No. | |
| EXAMINED | |
| MUNICIPALITY | |
| SOURCE OF SAMPLE | |
| COLOR | |
| ODOR | |
| TURBIDITY | |
| DISH + SOLIDS | |
| DISH + ASH | |
| WT. OF DISH | |
| TOTAL SOLIDS | |
| VOLATILE MATTER | |
| FIXED RESIDUE | |
| pH | |

| TUBE | AMMONIA NITROGEN | ALBUMINOID NITROGEN |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| TOTAL | | |
| Parts per Million | | |

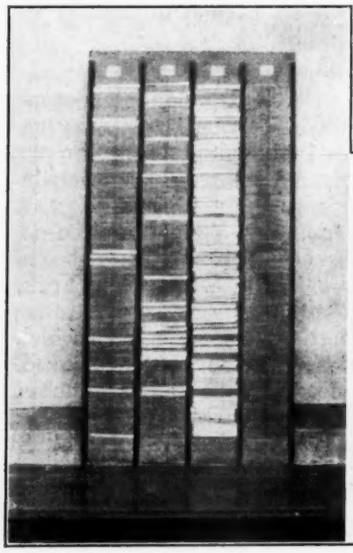
| | READING | PARTS PER MILLION |
|---|---|---|
| ORGANIC NITROGEN | | |
| NITRITE NITROGEN | | |
| NITRATE NITROGEN | | |
| CHLORIDE | | |
| EX. CONS. | | |
| ALKALINITY | | |
| TOTAL HARDNESS | | |
| IRON | | |

ANALYST

ABOVE: FORM ACCOMPANYING SAMPLE
BELOW: FORM FOR REPORTING RESULT OF ANALYSES

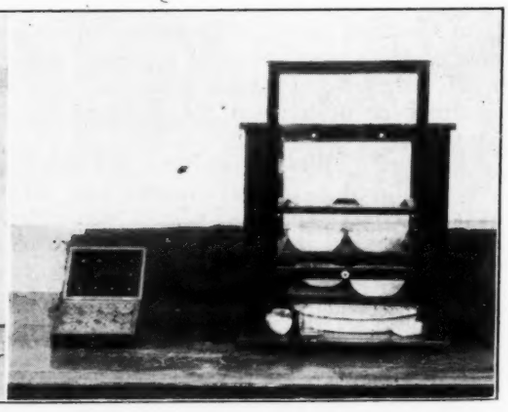
### PREPARING FOR THE ANALYSIS

The sample of water in the bottle is placed on a table 24″ x 36″ and 3 feet high (the height of all the laboratory tables), mounted on casters and rolled to an electric oven, which is maintained at 103° C. day and night; a porcelain nitrate dish, a 25 cc pipette and a 100 cc pipete, taken from a convenient drawer in the chemist's table, being



WALL RECORD BOARD

MOVABLE LABORATORY TABLE
BOTTLE TAGS HANGING ON LEGS



COUNTER WEIGHTS AND CABINET DESICCATOR

placed beside the water bottle as it passes this table.

A silica dish is then taken from the cabinet desiccator besides the balance and weighed as follows: the dish is put on the balance, its corresponding counter-weight placed on the other pan, and the rider adjusted or perhaps one small platinum weight added, and the balance released. The pointer is watched and when it makes only the first half swing and stops to start back, the point on the ivory scale is noted. The balance is then checked and the weight recorded both on a slate on the table in front of the balance, and on the analysis card. The platinum weight and the rider gave the milligrams and the point on the ivory scale the tenths of milligrams; there being only one, two or three figures to record, which represent units, tens or hundreds parts per million when 100 cc water is taken, as all the other weights have been covered by the counter-weight. Thus the figures noted represent the weight of the dish.

In the weighed dish then is placed 100 cc of the water, and 25 cc in the nitrate dish. (The tips of the pipettes are cut off for rapid delivery).

The two dishes are then put in the electric oven to evaporate and dry over night. This saves considerable time and avoids taking the water bath from other work next day.

The whole process of receiving samples, weighing dishes and putting the dishes for solids and nitrates in the oven occupies only a few minutes time in the afternoon, but it enables the analysis itself to be started promptly at 9:00 A. M. next morning.

### COUNTER WEIGHTS

Using a turning lathe, the writer made a set of twelve hollow brass weights, one for each silica dish, which are kept in a plush-lined cedar box. These weights are 1″ in diameter and ⅝″ high, are polished and laquered and present a creditable appearance. The knobs unscrew, and by inserting fine shot in a weight it is made to balance its corresponding dish within 10 milligrams. Weights and the corresponding dishes are numbered consecutively from 1 to 12. As the dishes change in weight by accumulation of solids or otherwise, adjustments are occasionally made. A slate on the table in front of the balance shows the weights of each dish every time the empty dish is weighed. The old practice of having a list of weights of dishes pasted up in the balance is utterly worthless for our purpose.

### METHOD OF WEIGHING

Our method of weighing is not new, but the writer has never seen it used save in some food laboratories when quick weights on open hygroscopic substances are desired. He has used it in water work for 20 years with complete satisfaction.

The balance is adjusted for this method as follows: The balance is loaded with about the average weight of the dishes and carefully balanced. The sensibility is then adjusted by moving the weight on the pointer until a weight of one milligram causes the pointer, when released without an impulse, to move from zero over just 5 subdivisions of the ivory scale, come to a stop and return. This gives a value of two tenths of a milligram to each subdivision or two whole milligrams to the end of the scale. A ten milligram rider is used, thus avoiding the use of weights smaller than 10 milligrams. For example: The balance is in adjustment. Place Dish No. 1 on left pan and counterweight No. 1 on right pan. Then place small platinum weight, if necessary, on pan, and rider on a whole milligram division on beam, noting by trial to see if the balance is sufficiently in equilibrium to keep the pointer from going beyond the ivory scale. Then close the balance case and release the balance carefully without an impulse. Watch the pointer move and note the exact point where it stops and starts back on the first half swing. This gives the weight immediately. Suppose a 10 milligram weight is put on pan, with the rider on 5 on a 10 division beam, and that the pointer swings out to 4 on the ivory scale; then the weight to be recorded is 158, which really means .0158 grams, or 158 parts per million if 100 cc water were taken. All other weights were taken up in the counter-weight. If the rider was on 2 on a 5 division beam, then the 10 milligram rider would count double and the weight would be 148. Of course the balance must ke kept in adjustment and in balance when empty at all times. This is not difficult with a good balance and ours keeps in adjustment for months at a time.

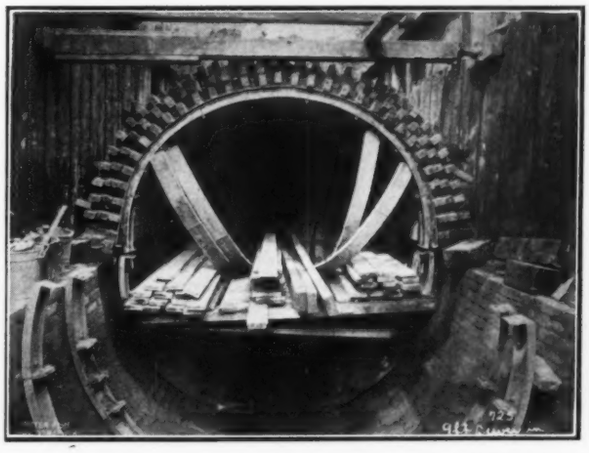
### THE CABINET DESICCATOR

This was made by the writer. It is a cabinet 13½ inches square and 15 inches high, built like a balance case, the frame being solid mahogany with a glass top, sides and bottom. It has a glass door balanced on weights and opening up and down like a balance case door. Three trays with wire netting bottoms slide in and out and carry four dishes each. A large pan of calcium chloride on the black glass bottom keeps the air dry. This desiccator is kept beside the balance, is a great convenience and is a good looking piece of laboratory equipment. The twelve silica dishes for solids are kept always at hand in this desiccator.

*(To be continued)*

## A Chicago Sewer Job

Construction of a 108-inch brick sewer was begun last year in Chicago by Mike Pontarelli, contractor, which involved some rather unusual difficulties. This part of the city stands on sand which was once the beach of Lake Michigan and which is from 15 to 20 feet deep. Excavation for the sewer was carried



END OF SEWER, SHOWING FORM RIBS AND LAGGING. STEEL SHEET PILING INSIDE OF WOODEN PILING ABOVE

through the sand to a total depth of about 20 feet, down a busy street in the densely populated north side of the city, where heavy traffic had to be provided for and the street kept open. This sewer replaced an old one, which necessitated caring for all the house connections and branch sewers which had discharged into the old sewer.

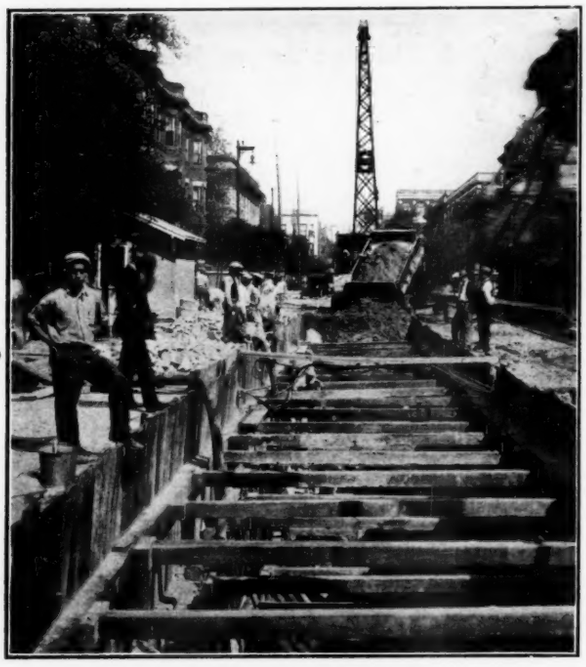
The pavement had been laid on a heavy concrete base, and a Northwest pull shovel was used to remove the pavement and also to carry the excavation down at the full width for a depth of about 10 feet. During this excavation this upper ten feet was sheathed with timber. Following this, steel sheet piling was driven on each side, inside the timber sheathing, using compressed air and water jets. The remaining ten feet were then dug by means of a clam-shell bucket handled by a Northwest crane travelling along the side of the trench.

An effort was made to handle the water in the trench by an 8-inch subdrain laid underneath the brick sewer. Due, however, to inability to keep sand out of the drain, this plan was abandoned and pumps were used to lift the water and sewage from the bottom of the trench.

Following the installation of the brick work by the masons, the spoil from the excavation was brought back in trucks for backfilling and pushed into the trench by a tractor and by means of a bull-dozer on a crane. This crane was also used to pull the sheathing. Throughout the job the distance between the pull shovel doing the preliminary excavation and the crane doing the backfilling never exceeded 250 feet.

CARRYING TRENCH UNDER ELEVATED RAILROAD

PULLSHOVEL DIGGING UPPER TEN FEET



CRANE (IN BACKGROUND) PULLING SHEETING AND BACKFILLING

At one point on the job the route of the sewer was crossed by the structure of an elevated railroad, which limited the head room. Nevertheless, the pull shovel and cranes worked satisfactorily under these low quarters, the operators finding no difficulty in booming up and down under the overhead railroad.

A description of this work was published in "Material Handling Illustrated," to which we are indebted for the accompanying illustrations.

## Sewage Treatment in Connecticut

In the April number of the monthly "Health Bulletin" of the Connecticut State Department of Health, Warren J. Scott, the director of the Bureau of Sanitary Engineering, gives a brief statement concerning the present status of sewage treatment in that state.

He says that at the present time no public water supplies are drawn from streams receiving discharge from public sewerage systems in that state. "While this is extremely fortunate, this has undoubtedly retarded the amount of progress made in cleaning

up our inland streams. It is brought about because it is possible to secure good water from upland streams in thinly populated areas to supply our various cities, towns and villages, mostly by gravity. The day is undoubtedly coming, however, when the growth of population will make it necessary to turn to streams receiving sewage discharge for water supply needs. . . . . It is generally recognized in such cases that an upstream community must so treat its sewage as to avoid unnecessary burden upon the purification plant of a downstream water supply."

There has been considerable agitation among the shore communities concerning the effect upon bathing of dumping increasing amounts of untreated sewage into Long Island Sound. Pollution of shell fish areas also is becoming important and in 1927 the State Department of Health closed for market purposes three such areas and legal proceedings have been instituted by one or two shell fish dealers against cities polluting the harbors.

He lists 35 municipal sewage treatment plants in the state, 3 of them for the one city of Middletown. Of these, 15 give the sewage preliminary treatment in septic tanks, 10 in Imhoff tanks, 2 in fine screens, 7 by sand filtration, and one by settling in a shallow gravel basin. One of the sand filtration plants treats the excess night flow by chlorination only.

Twenty-one of the plants give no secondary treatment to the sewage, 7 subject it to sand filtration, 5 to chlorination, one uses contact beds, and one a trickling filter. Chlorination follows septic tanks in two plants and Imhoff tanks in the other three. Sand filtration follows septic tanks in four cases, fine screens in one, and Imhoff tanks in two. The contact bed is used in connection with a septic tank and the trickling filter in connection with an Imhoff.

# Rigid Frame Construction for Westchester County Park Commission

By Arthur G. Hayden, M. Am. Soc. C.E.*

The bridges of the Westchester County Park Commission, beside being beautiful examples of stone and concrete architecture, mark a distinct advance in engineering design. Continuous construction has been applied to these bridges "with results so impressive in increased efficiency and esthetic range as to forecast an important influence on short-span practice"; and the development is of sufficient importance to claim consideration for very many structures that will have to be built in the years immediately ahead—structures for grade crossing eliminations, new municipal, county and state bridges; and not bridges alone, but buildings as well; for the beauty of structural form that has been obtained with rigid frames for bridges can be extended to many other applications. Large areas for industrial buildings can be roofed with economy by the use of indeterminate portals of reinforced concrete or steel as the main structural element; the mission of trusses adding beauty to the structure and improving the lighting.

Until quite recently the principle of simple span or discontinuous construction held sway almost unchallenged as the dominating principle of structural thought. The definite aim in the design of every structure was to maintain a complete separateness of action of its component parts—beams, columns, braces and supports—partly because the methods of calculating any other kind of structure were unknown or at best extremely difficult, and partly because of a suspicion of any form of construction that required higher mathematical analysis—a very natural mental bias. Thus we see most of our bridges consisting of girders, carrying a floor system separate in action from the girders and the girders in turn supported on piers or abutments, but having no structural continuity therewith. The floor systems themselves were invariably constructed of separate systems of transverse and longitudinal beams and a floor deck. The most important exception to this general rule is the arch; but this as a calculable structure is also a recent development, although the empirically designed masonry arch is one of the oldest of structural forms.

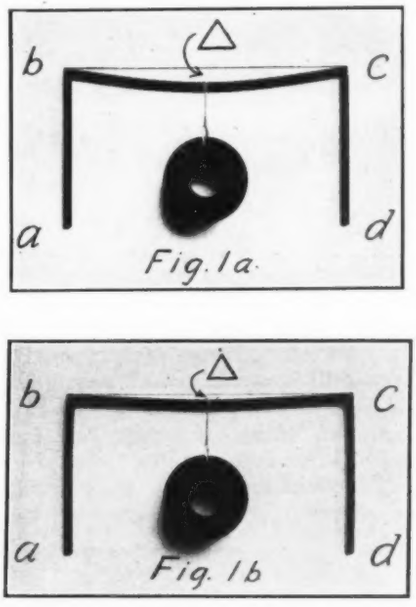


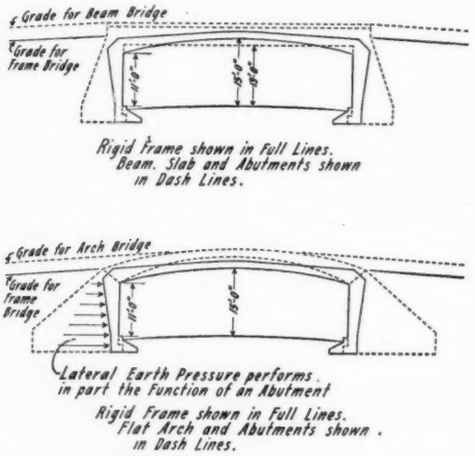

FIG. 1—MODELS ILLUSTRATING ACTION OF GIRDER BRIDGE AND RIGID FRAME BRIDGE

The planning of the Westchester bridges is an important step in the direction of continuous construction. The principle of continuity was deliberately applied in the invention of a new structural form

*Designing engineer, Westchester County Park Commission.

calculated to best meet conditions imposed by restricted headroom at highway crossings and possessing the utmost flexibility for architectural treatment. Moreover, the new type of structure showed substantial economy. Construction advantages were gained at reduced cost.

The illustration, Fig. 1, shows the reason for the inherent economy of the type. The figure is a photograph of toy structures loaded with an iron weight; the upper one representing the action of a girder bridge merely supported on its abutments; the lower one representing a rigid frame bridge, the same members being rigidly connected so that they are continuous from footing to footing. It is an engineering principle that the work done by a structure in supporting a load is measured by the product of the load and the deflection of the structure at and in the direction of the load. In the above illustration it is seen that the three members of the continuous structure all acting together have to perform only 0.4 the work that the one horizontal member of the girder span has to do alone.


℄ Grade for Beam Bridge
Grade for Frame Bridge
Rigid Frame shown in Full Lines. Beam. Slab and Abutments shown in Dash Lines.
℄ Grade for Arch Bridge
Grade for Frame Bridge
Lateral Earth Pressure performs in part the Function of an Abutment
Rigid Frame shown in Full Lines. Flat Arch and Abutments shown in Dash Lines.

FIGS. 2 AND 3—COMPARISON OF RIGID FRAME DESIGN WITH USUAL FORMS OF BRIDGE CONSTRUCTION

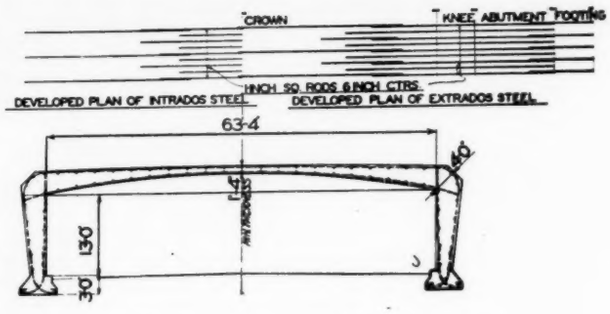



FIG. 4—TYPICAL DETAILS OF ONE-SPAN FRAME BRIDGE

In an actual structure the members are not all of the same width throughout their length as in the toy structures referred to, but the material of the structure is placed where it will be most effective. Fig. 4 shows the longitudinal section of a frame bridge on the Saw Mill River Parkway which required only 60 per cent. of the material that would be required for a constant-section frame—that is, one having members of uniform width. As a matter of fact, a constant-section frame would be impractical for a bridge of this span or even considerably less span.

Fig. 2 illustrates the saving in the approaches effected by the rigid frame bridge as compared with a beam bridge; both being reinforced-concrete structures.

Fig. 3 shows a like comparison of the frame bridge with the fixed arch which requires a greater rise (with consequent loss in the approaches) in order to meet the stresses due to temperature change. Note also the saving in material due to the elimination of the massive arch abutments required to fix the arch ring, and which must be heavier and heavier as the arch ring becomes flatter and flatter.

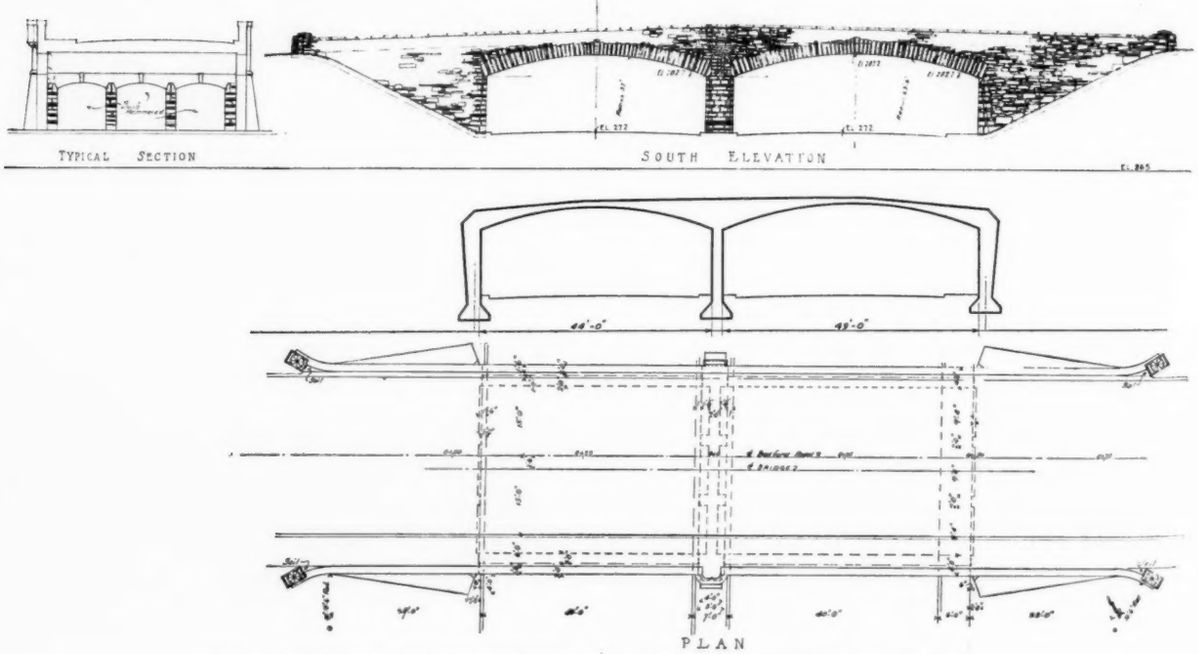
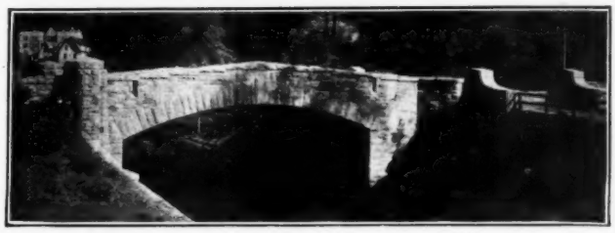



FIG. 5—TYPICAL CONSTRUCTION OF PROPOSED TWO-SPAN BRIDGE



COMPLETED BRIDGE FOR WHICH TYPICAL STRUCTURAL DETAILS ARE SHOWN IN FIG. 4.

Fig. 4 shows typical details of a one-span frame bridge, of which a number have been built on the Westchester County Parkways.

Fig. 5 shows typical construction of proposed two-span reinforced-concrete frame bridges of which there are to be a number.

Fig. 6 shows a three-span frame bridge (over a roadway and two side-walks) of which two have been built. Ribbed construction (the bridge consisting of a number of longitudinal girder frames supporting a floor) was used here in order to mitigate the effects of skew which is a disturbing factor in the calculation of stresses. Although certain stress effects of skew exist in the ribbed type and were accounted for in design, it was felt that other effects not easily calculable were minimized by this construction so that the design would be safe. There have been in the past many failures of solid skewed arches, some attended by loss of life, due to the fact that there were no known methods of stress analysis permitting a proper design.

Following the notable work of Professor Rathbun in solving the skew arch problem and the substantial verification of his theory by the experiments of Professor Beggs of Princeton University, the Westchester County Park Commission engaged Professor Rathbun to develop the method of analysis for skewed frame bridges.

A ribbed type design had been made for Fenimore Road Bridge, Hartsdale, which is on a 54-degree skew, but construction was delayed pending the results of Professor Rathbun's work so that it could be applied in securing a simpler and more economical structure and one much more pleasing architecturally. The checking of Professor Rathbun's method of analysis, and the actual calculation of the new design for this bridge were conducted by air-mail between Professor Rathbun, in South Dakota School of Mines, and the designers of the Commission (H. G. Babcock and Bernard L. Weiner) in Bronxville, N. Y. The bridge was opened to traffic in 1927. Two other skewed frame bridges will be opened to traffic in the near future.

Fig. 7 shows the arrangement of steel in the top of one of these skewed bridges, and by comparing with Fig. 4 it will be seen that the stresses induced by the skew require main transverse reinforcement as well as longitudinal reinforcement. The transverse steel in Fig. 4 consists of tie rods only—no calculated reinforcement.

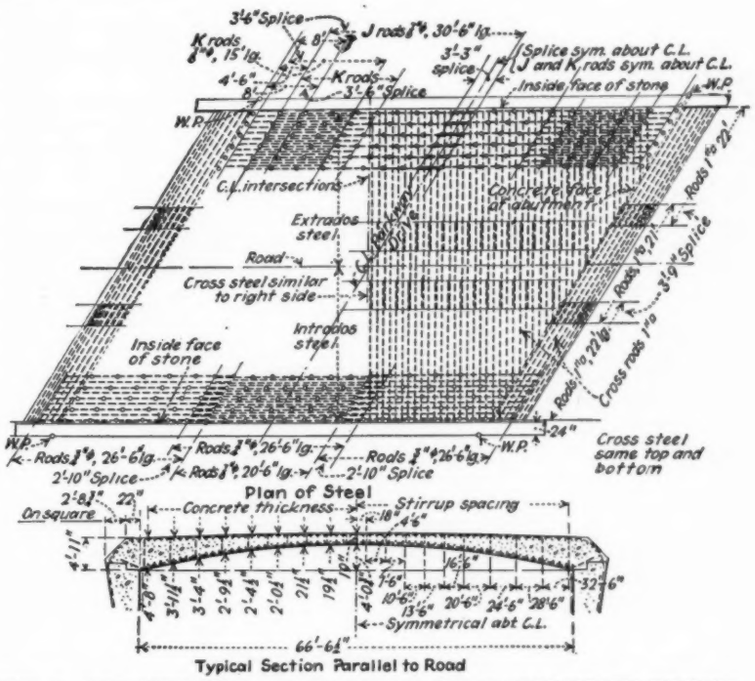



FIG. 7—ARRANGEMENT OF STEEL IN OLD MAMARONECK BRIDGE.

Fig. 8 shows a "through" bridge consisting of two rigid frame girders carrying the floor system.

Fig 9 shows the rigid frame idea applied to steel construction. One bridge of this type is under construction and others are being designed. Preliminary estimates indicate considerable economy for this development. A careful study is being made to determine the exact relative economy as compared

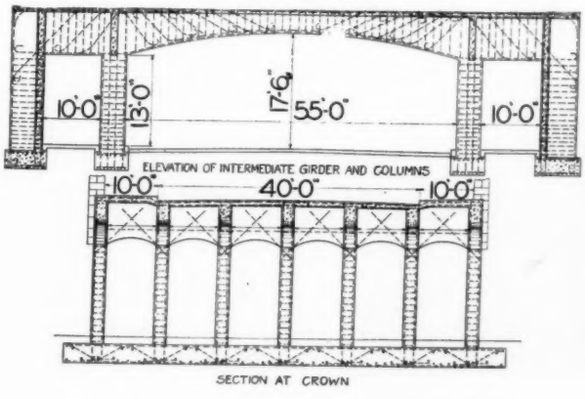



FIG. 6—THREE-SPAN FRAME BRIDGE.

COMPLETED BRIDGE FOR WHICH TYPICAL STRUCTURAL DETAILS ARE SHOWN IN FIG. 6.

with the other types shown in the table of cost comparisons.

From the above illustrations, particularly Figures 4 and 5, the extreme simplicity of construction of the solid section frame bridge will be noticed. Such details as hinges, rockers, roller bearings, sliding joints, etc., are lacking. These expedients are used in statically determinate bridges to insure separateness of action of its component parts so that the stresses in each may be calculable in accordance with the laws of statics. Their omission, as in the rigid frame bridge, while simplifying construction, makes the stresses in the structure incalculable by static analysis. Strange as it must seem, the simpler structure is by far more difficult to calculate, as to stresses, than the more complicated structure. The commission developed new methods of analysis applying to this new type of structure and has simplified them as investigation and research showed the effect of the various elements of design.

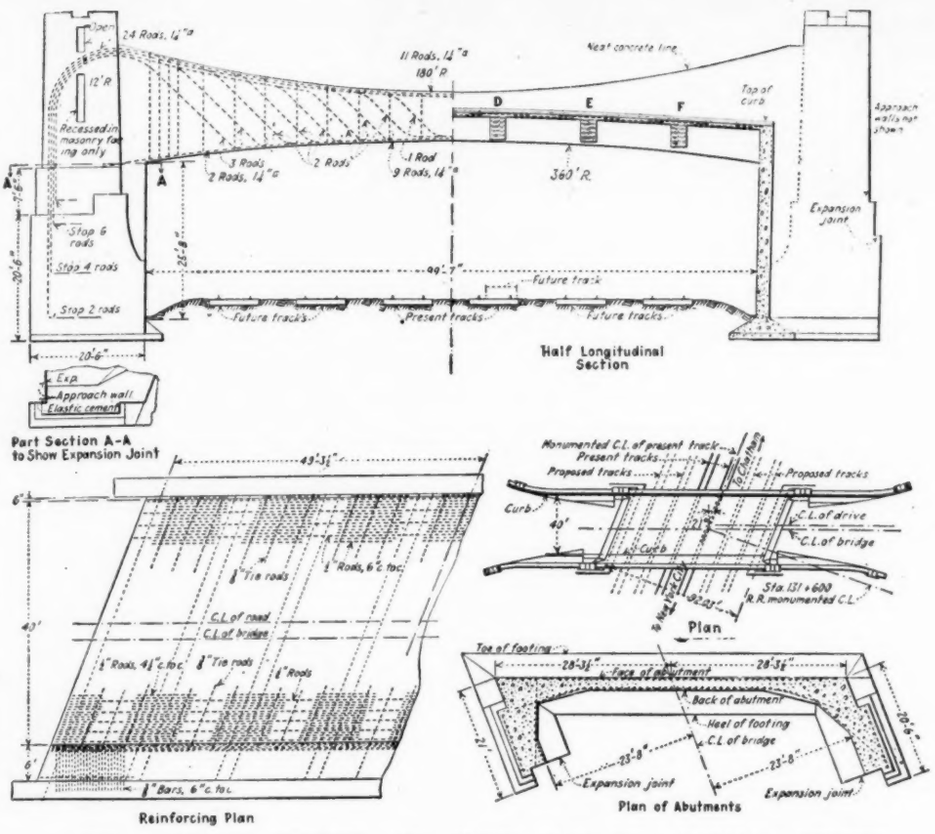


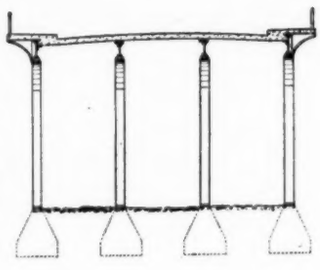

FIG. 8—FRAME GIRDERS AND FLOOR SLAB OF VALHALLA BRIDGE

The table below is a careful comparison of the cost of a reinforced-concrete frame bridge, a reinforced-concrete arch, and a steel girder bridge with concrete abutments. The concrete frame and the arch are concrete surfaced bridges—*without* stone facing. Each bridge is for 76 ft. clear span, carrying a 40 ft. roadway.

| | *Main Structure* | *Approaches* | *Total* |
|---|---|---|---|
| Concrete frame bridge.. | $27,000 | $42,000 | $69,000 |
| Steel girder bridge..... | 31,000 | 52,000 | 83,000 |
| Concrete arch bridge... | 35,000 | 38,000 | 73,000 |

The substantial economies effected by the frame type of construction goes far in paying for the expensive stone facing of the Westchester bridges that has made them the most beautiful in the world. The economy of construction lies partly in the structures themselves and partly in the approaches—the saving in floor depth reducing the quantities in the approach fill.

The work of the Westchester County Park Commission has been followed with interest by the engineering profession, not only in this country but abroad. Representatives have been sent to the offices of the Westchester



COMPLETED BRIDGE FOR WHICH TYPICAL STRUCTURAL DETAILS ARE SHOWN IN FIG. 8
Through bridge consisting of rigid frame girders carrying the floor system

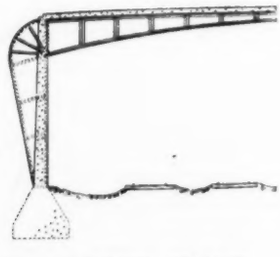


FIG. 9—TYPE OF RIGID FRAME STEEL GIRDER BRIDGE, SPAN 60 TO 100 FEET

County Park Commission to study its work and the new methods of design are being taught in some universities and colleges. New York State, the Connecticut State Highway Commission and the Long Island State Park Commission are now building rigid frame bridges of the Westchester type and the New York Central Railroad is designing some for railroad grade crossing elimination projects. Others are falling into line.

The future development of this type of construction will undoubtedly produce some interesting results.

## Alberta Highway Work

In spite of the fact that the season of 1927 was the most unfavorable for highway work of any encountered for many years, the Department of Public Works of Alberta was able to make a very creditable showing. Contracts were awarded for grading about 140 miles of main highways of which 119 were completed: for gravel surfacing 177 miles of main highways of which about 134 miles were completed; and completing 41 miles of gravel surfacing for which contracts had been awarded in 1926. The total amount spent by the province on main highway construction in 1927 was $851,675.

Included in this work was the completion of gravel surfacing of the main highway from Edmonton to Nanton, a distance of approximately 270 miles and it was expected that this would be completed during May, 1928, except for a 30-mile stretch. Constructing roads to the Peace River country was prevented by high water.

The department spent $195,378 in maintaining 2,780 miles of main highway and $10,517 for maintaining other roads. Administration, machinery, equipment and sundries brought the total for maintenance to $236,205.

During the year 375 new bridges were constructed, including 29 steel ones, the cost of which was $500,039; and $63,208 was spent in bridge maintenance. The Government also operated 56 government-owned ferries at a cost of $51,795.

The Government owns a system of market roads throughout the province but work on these is up to the jurisdiction of the various municipal districts, although the province grants 50% of the cost, which last year amounted to $348,942. It also granted $213,878 for construction of local roads.

## Semi-Trailers on Road Construction

In constructing concrete highways in the vicinity of Detroit, Mich. the R. D. Baker Company, paving contractor, with headquarters at Royal Oak, Mich., uses to advantage a combination of semi-trailers and industrial railway for hauling the concrete material to the job.

The company's general practice is to establish elevated measuring hoppers on a railroad spur near one end of the contract to be performed, and haul the material in semi-trailers, in batches, four batch-boxes on a trailer. The tractors use the new concrete pavement to a point as close to the work as the pavement is sufficiently set, at which point the trailer is backed up to the end of the industrial railway track, which at this point is elevated so as to be on the same level as the bed of the trailer. The batch boxes are all mounted on trucks, and are run from the trailer onto the track, made up into trains and hauled by locomotive to the mixer.

As soon as the loaded batch-boxes have been removed from the trailer, four empty boxes are pulled up the incline track onto the trailer by means of a cable and winch driven by a chain and stroket set on the tractor pulley shaft. (This cable is also used to control the speed of the batch-boxes while unloading.) The empties are then hauled on the trailer to elevated hoppers, run under the hoppers and loaded with the proper amount of gravel, sand, and cement, and then back to the end of the industrial railway track again.

The number of tractors and semi-trailers used of course varies with the distance to be covered, but averages about 15, each drawing 5½ cubic yards of material or more. The company owns seventeen McCormick-Deering industrial tractors, and makes its own semi-trailers and batch-boxes.

In moving from one job to another, the mixer travels under its own power, while the locomotives are run onto the trailers which carry the batch-boxes. The industrial track, of which there is a length of from two to four blocks, can be loaded on the trailers, transported and relaid in a comparatively short time.

## New York Highway Notes

In his report for 1927, A. W. Brandt, Commissioner of Highways of the State of New York, says: "Due to the usual stocking of materials in the fall of the year, emergency repairs and oiling operations were carried on even more speedily than usual. One of the greatest causes of complaint from the traveling public in past years has been the lack of speed and system with which oiling operations have been carried on, this work in many districts formerly running well into the middle of the summer. For the past several years, due to arrangements having been completed in the fall of the previous year, all oiling operations have been completed before June 1st and long before the touring season started. This has resulted in almost universal satisfaction although we can never hope to attain complete satisfaction as long as we have types of road which require surface treatment.

"The bulk of the reconstruction work during the year consisted of heavy reinforced concrete but, as in new construction, a considerable mileage of resurfacing with bituminous macadam, strengthening the old roads wherever weaknesses appeared, was resorted to. In the mountainous region this type was found to be not only much more economical than concrete but is also quite satisfactory for the light character of traffic that uses it."

### TOWN AND COUNTY ROADS

State appropriations and motor vehicle fees available for town highways and county roads in New York in 1927 totalled $10,029,239; of which $2,380,070 was State Aid to counties, $2,910,000 State Aid to towns, and $4,739,169 was from motor vehicle fees.

These funds, with town and county appropriations and bond issues, provided approximately $40,000,000 for the maintenance and improvement of town highways and county roads. This tremendous amount of money was spent by the towns and counties under loosely drawn laws controlling its expenditure.

In many counties the money is apportioned by the board of supervisors to the towns, individual towns receiving from $1,000 upward.

"It is safe to say, and our observations bear it out, that much of this money is spent inefficiently. This is not at all surprising. It is not reasonable to suppose that town superintendents, usually chosen, not for their ability to build roads, but for their ability to obtain votes, should be able to spend these millions in the most efficient maner. No community would think of choosing a layman for health officer or town attorney simply because he was a popular man and without regard to his qualification for the post. Why then should that same community choose a layman for its town superintendent of highways because he is popular and without regard to his knowledge of road building? Town superintendents, or better still, district superintendents or foremen, whose duties may include construction and maintenance of all roads in one or more towns, should be chosen by the county superintendent of highways and should be directly responsible to that official and the board of supervisors."

# Backfilling Street Cuts in St. Louis

The subject of street cuts was discussed before the convention of the International Association of Street Sanitation Officials by Robert B. Brooks, director of streets and sewers of St. Louis, Mo. He stated that in 1927 the city of St. Louis issued 12,060 permits for excavations in its streets; which excavations ranged from an ordinary 2x4-foot plumber's cut to the laying of a gas main two miles long in a major street.

Utility companies in St. Louis have for the past two years co-operated with the city departments in using a quick-setting cement in all underground concrete structures in the downtown congested district. By this means it is rendered possible to remove barricades and accident hazards from ten days to two weeks sooner than when ordinary portland cement was used. All parties excavating in the congested district of the city are required to work every day, including Sundays and holidays, and sometimes at night, in order to close excavations as quickly as possible.

In backfilling trenches, hand tamping of thin layers of earth is unsatisfactory on account of the human element. A man is not a machine and it is not possible to pick up a 20-pound tamper and drive it home with the same force at 5 o'clock in the afternoon that it was at 8 o'clock in the morning. You will often see a laborer using a tamper when the foreman is not looking slide his hands up and down the handle of the tamper without raising it even a fraction of an inch.

Recently the public utility companies in St. Louis have been using air tampers. The results have been not only more satisfactory than hand tamping, but a money saving has been effected.

The department has under consideration at present a proposed change in the existing ordinance, requiring all parties making excavations for any purpose to use air tampers in the compression of dirt in backfilling the trenches. Under tests it has been found that the average hand-tamped trench gets only about 70 per cent. of the earth returned to the excavation, and that with air tampers about 90 per cent. of earth excavated can be returned to the trench.

Depressions in excavations for mains and conduit extensions where air tamping has been used are reduced to a point where they rarely occur. The depressions in small service cuts are more numerous, and it is with these in mind that the department is considering the use of air tampers in all cases.

Those companies making many cuts would find it advantageous to have their own air compressors. Many plumbers would find it uneconomical. In case the party making an excavation is not equipped to backfill with pneumatic tampers, the street department should furnish service for the backfilling at a price based on the cost of the particular work done, which should include depreciation on the equipment as well as overhead of the department.

When a backfill has been air tamped up to the subgrade, the concrete base should be trimmed back at least 6 in. behind the line of excavation and a new base constructed. Then the wearing surface should be applied at least 2 in. behind this line so as to eliminate as far as possible the possibility of a depression cracking off the pavement on the lines of the excavation should it settle further.

The public utility companies are willing to cooperate on the method of pneumatic tamping, after being sold on the reduction of costs effected. The plumbing companies are against it because they believe it will mean less work for them should the city make the backfills. A program of education is necessary to sell them and the general public before an enforcing ordinance can be passed on this point.

Utility excavations in streets are a sign of progress. They must be treated as individual problems so as not to constitute a potential accident hazard. The best way to accomplish this where new utility mains are to be laid, is to place them in the space between the sidewalk and the curb instead of in the roadway.

## Felt Base for Concrete Pavements

A new idea in constructing concrete pavements was incorporated in a section of pavements laid recently in Santa Clara County, Calif., which consisted in laying on the subgrade a damp-proof base consisting of layers of an asphalt-impregnated felt sealed with a brush coat of hot asphalt. The advantages claimed for this base were that it would prevent the change of water cement ratio which frequently occurs in concrete laid directly on porous dry soil; and that it would break the bond with the subgrade and so permit free movement of the pavement between expansion joints.

In order to determine the best method of laying such a pavement and to compare costs, strength and uniformity, alternate sections of the pavement were laid with and without this base, which is known as the Monolite base. The slab was laid 11 feet wide (part of a widening project) and 7 inches thick, with

an outer edge thickness of 9 inches. Expansion joints were placed every 60 feet, with dummy joints at 20-foot intervals. Each slab was separately reinforced with two strong bars, one above the other, on each of the four sides.

Excavation was carried about six inches below the base of the slab and the space was refilled with selected imported material. This was rolled and afterwards bladed to about three-quarter inch below the specified subgrade, filled to grade with sand, and struck with a template. Although the laying of the damp-proof base was obstructed by the reinforcement and the gauge-rail supports, it was found that it could be laid faster than the concrete could be poured. It also appeared that where the damp-proof base was used, the water content of the 5-bag mix could be reduced at least one-half gallon and give equal workability. The elimination of loss of concrete in the wet earth subgrade, amounting often to from 4 to 7 per cent, together with a saving of labor and water for wetting the subgrade, partly offsets the cost of the base itself.

The contractor on this project was the Allied Contractors, Inc., of Omaha, Neb., while the base was laid by the Monolite Company of America, of San Francisco.

## Unit Prices, Oklahoma State Highway Work

The following are the average unit prices for the 1927 formal contracts of the Oklahoma State Highway Commission. The quantities involved are given also.

| *Item* | *Quantity* | *Av. Unit Price* |
|---|---|---|
| Earth excavation | 1,797,295 | $0.2547 |
| Loose rock excavation | 110,341 | 0.5169 |
| Solid rock excavation | 194,667 | 1.1724 |
| Channel excavation | 203,609 | 0.2955 |
| Borrow | 1,656,115 | 0.2260 |
| Overhaul | 1,016,220 | 0.0587 |
| 15″ R. C. pipe (furnished by State) | 64 | 1.2500 |
| 15″ R. C. pipe (furnished by contractor) | 52 | 2.0000 |
| 18″ R. C. pipe (furnished by State) | 2,566 | 1.4407 |
| 18″ R. C. pipe (furnished by contractor) | 6,244 | 2.6524 |
| 24″ R. C. pipe (furnished by State) | 3,644 | 1.8461 |
| 24″ R. C. pipe (furnished by contractor) | 3,944 | 3.1797 |
| 30″ R. C. pipe (furnished by State) | 2,248 | 2.4500 |
| 30″ R. C. pipe (furnished by contractor) | 1,980 | 4.9262 |
| 30″ R. C pipe (furnished by contractor) | 628 | 7.3359 |
| Class A concrete | 26,039 | 20,3961 |
| Reinforcing steel | 2,082,932 | 0.0534 |
| Laid up rip-rap | 2,114 | 2.1707 |
| Section markers | 85 | 12.7000 |
| Reinf. Conc. pavement | 1.144,111 | 2.2443 |
| Conc. curb & base 1:3:6 | 249,237 | 1.5980 |
| Base 1:3:6 for brick | 8,782 | 1.4847 |
| Gravel base | 1,690 | 2.2000 |
| 4″ Rock asphalt base (Cold) | 2,952 | 0.8000 |
| 4½″ Rock asphalt base (Cold) | 3,978 | 0.9000 |
| Concrete curb | 11,071 | 0.3200 |
| 1½″ Rock asphalt | 177,935 | 1.4511 |
| 2″ Rock asphalt (Cold) | 5932 | 1.1500 |
| 2″ Rock asphalt (Hot) | 3,514 | 1.2845 |
| 2½″ Vit. brick | 8,405 | 1.6370 |
| Gravel surfacing | 6,854 | 1.9958 |
| Cable guard rail | 64,058 | 0.6109 |
| BRIDGES | | |
| Class A concrete | 16,170 | 21.0663 |
| Class A concrete (Pier tops & abutments) | 2,079 | 24.1552 |
| Class A concrete (Pier bases) | 3,811 | 34.6403 |
| Class AA concrete | 10,250 | 21.9155 |
| Reinforcing steel | 2,276,367 | 0.0487 |
| Structural steel | 8,671,484 | 0.0591 |
| Rock excavation | 271 | 15.4059 |
| Borrow | 27,711 | 0.2742 |
| Rubble masonry | 64 | 14,000 |
| Expansion plates | 59,600 | 0.0782 |
| Concrete hand rail | 22,561 | 2.0049 |
| Untreated timber piles | 32,020 | 0.9509 |
| Creosoted piles | 32,914 | 1.0434 |
| Concrete piles | 44,701 | 4.1308 |
| Untreated timber | 597,720 | 59.9926 |
| Untreated and painted timber | 61,250 | 103.3900 |
| Creosoted black gum | 73,300 | 120.6481 |
| Creosoted timber | 297,870 | 112.5126 |
| Laminated floor | 2,555 | 8.8545 |
| Creosoted floor | 16,100 | 130.0000 |
| Untreated timber floor | 1,406 | 13.7892 |
| Pier bases pneumatic | 651 | 52.0000 |
| Untreated timber floor | 135,100 | 62.7000 |

# Schenectady Sewage Plant Operation

**Some details of 1927 experiences. Hosing gas vent scum reduced. Spring operation of Imhoff tanks. Chlorinating sewage. Sludge as fertilizer. Animal life in trickling filters**

The sewage treatment plant at Schenectady, N. Y., was described in *Municipal Journal* (as PUBLIC WORKS was then called) for April 15, 1915. As stated therein, serious construction difficulties interfered with carrying out plans as originally made, and this has resulted in the plant being operated under greater disadvantages than are encountered at most plants of this kind—Imhoff tanks and sprinkling filters. This was brought out in the article on Imhoff tanks in our issue for March, 1924. In spite of this, however, excellent results have been obtained during recent years owing to the careful, intelligent and skillful operation of the plant. For which reason it is of special interest to sewage engineers.

In his report of the thirteenth year of operation, that of 1927, the superintendent, Morris M. Cohn, states that it can be said this year, as in each of the previous years, that the past year was perhaps the period of most satisfactory performance that the treatment plan has experienced.

"Experience and study have been essential for a clear understanding of the principles involved in the disposal of the liquid wastes of Schenectady by biological means. The past few years have seen the rise of many new theories on bio-chemistry of sewage treatment and Schenectady has not failed to study their practical application."

The plant has been so outgrown that it is capable of treating but 65% of the sewage of the city under ordinary conditions, and at times much less than this percentage of the total flow can be passed through the plant.

### HOSING GAS VENT SCUM

Perhaps the most important feature of the year's operation was the success attending the decrease in the amount of hosing during the sludge drawing period. In the past hosing (application of water by hose to the scum in the gas vents to break up

same and drive it to the bottom of the tank) usually started in April and continued throughout the entire summer, the tanks being hosed regularly before each sludge withdrawal operation and many times in between. During 1927, hosing was not started until May and was then continued only until the solid mass of scum 7 feet thick in all vents had been hosed but once. Hosing was then discontinued until the last week in July and August when agitation of the vents containing heavy scum deposits was carried out at infrequent intervals. "A time schedule study indicates that something like 15% of the usual time was spent upon this phase of operation and that only this percentage of agitation of the material in the scum and sludge compartments resulted. The decreased hosing resulted in improved tank appearance due to a reduction in the amount of solids driven up through the slots into the sedimentation compartments." Apparently the breaking up of the scum and driving it down into the body of the tank, combined with the addition of water to the gas vents which caused the contents to stand higher there than in the sedimentation channels and thus to flow through the slot back into the sedimentation channels, resulted in their receiving some of the broken masses of scum.

"Reduced hosing was also accompanied by a reduction in the foaming phenomenon. There was no summer, and the incipient overflowing of the gas vent boxes by frothy scum was evident in but few vents on an equally few occasions."

The most important result was the large amount and smooth texture of the sludge withdrawn from active foaming of any description during the entire the tanks. This was no longer a mixture of sludge, scum and water which had usually resulted from scum hosing before drawing sludge. Sludge was drawn in considerable quantities throughout the summer and was always available for withdrawal. The moisture content was consistently lower than any sludge ever produced previously by the Schenectady tank, varying from a maximum of 94.9% to a minimum of 89.8%, the weighted average of all sludge drawn being 91.9%. The organic content varied from 53.83% to 66.44%. A total of 7,219 cubic yards of wet sludge was removed from the tank which, considering the low moisture content, was the largest solids removal in the entire period of plant operation. That the reduction in hosing effected a large reduction in the amount and cost of labor required about the plant was an additional advantage.

### SPRING OPERATION OF IMHOFF TANKS

The beginning of 1927 had found the tanks in their usual condition, with a rather thin scum blanket and little solids available as sludge. Radical solids removal had been practiced during the previous fall to provide the much-needed storage space for the winter, although the upsetting of the optimum balance of digested solids and fresh solids was undesirable. Belching of solids up through the slots to the tank surfaces was noted in some tanks as early as January, and in February solids began to accumulate above the slots. The scum blanket became heavier and the building down of the scum to the level of the slot prevented the transfer into the sludge hoppers of solids deposited in the sedimentation channel. As soon as this condition was reached, the tanks thus loaded were shut down by closing the feeder gate and rested until the slots became clear. In this manner the units were rotated in non-operation until May, when sludge drawing had proceeded far enough to relieve the tanks. Many attempts were made to drive the solids through the slots into the sludge hoppers. Slicing bars were tried, heavy streams of water at the ends of pipes were played upon the slots in an attempt to blow them clear. An attempt was made to siphon the solids out of the sedimentation chambers into the gas vents. None of these was successful, but the deposits disappeared rapidly when the sludge drawings began. Although the sedimentation channel contained floating sludge during the entire winter, no sludge left these units with the effluent. As soon as sludge withdrawal was well under way, the tank surfaces cleared up and presented a fine appearance during the summer and fall.

### CHLORINATION OF SEWAGE

"An investigation was carried out during the winter of 1926-1927 to ascertain the exact effect of chlorination of raw sewage, prior to tank treatment, on the digestion of solids deposited in the tanks during the winter storage period. Observations made on sludge drawn from a chlorinated tank and from an untreated tank indicated that no deleterious effect was produced by gas treatment. Of all sludge drawn from these two tanks, the odor was similarly slight while the color and consistency of the former sludge has possessed more markedly those characteristics usually associated with well-digested sludge." Chlorine was applied at the rate of approximately 4 parts per million during this study but no residual chlorine was found in the tanks. No bacterial reduction in the tank effluent was obtained by chlorination of the raw sewage, and it is to be assumed that residual chlorine at the inlet end of the tanks must be maintained before such reduction in bacteria can be expected.

During the year a chlorinator was purchased and installed at the sewage pumping station, located about two miles above the plant, and chlorine was added to the raw sewage in the pump wells at rates varying from 6 parts to 2 parts per million. Appreciable quantities of additional sewage entered the sewer half a mile below the station and reduced the rate of chlorination to form 4 to slightly less than 1 part per million. Naturally, no evidence of residual chlorine could be found at any point in the sewage system below this point. When the chlorine rate was 4 parts per million there was a most distinct reduction in normal sewage odors about the tank, siphons and filters. The usual chloro-substitution odor could be detected, and when the rate of application was raised to about 8 parts per million the odor became more marked. Chemical analyses of samples taken at various parts of the sewer and tank inlets indicated that chlorination had slight effect on the chemical constituents of sewage. With cooler weather, odor was controlled with the application of slightly better than one part per million of chlorine.

### SLUDGE AS FERTILIZER

All of the sludge from the sludge drying beds is removed by farmers; in fact in the spring of 1927

they even raked the beds in order to obtain additional small quantities. The demand for the sludge comes in the spring, and that removed during the rest of the year is placed in storage piles, to be removed early the next year. Satisfactory results were reported from the use of the sludge on all types of crops, and farmers from all sections of the county and nearby counties hauled the material, paying for it 25c. a load of approximately 2½ yards. All farmers were notified to keep sludge from such crops as grow in or on the ground and are eaten raw. Efforts were continued to bring the merits of sludge as a fertilizer to the attention of all farmers of the section by means of talks and articles in the papers.

One little "wrinkle" reported by Mr. Cohn was that, by leaving a thin strip of dried sludge along the partitions between the sludge beds, the wet sludge was prevented from breaking through under the board division walls into the beds adjacent to the units being used.

Screenings intercepted by the stationary bar rack ranged from 1.5 cubic feet per million gallons to 2.8 cubic feet, monthly averages. That obtained during the winter months was stored at the sides of the dump tresele and in March, before the frost had left the mass and prior to any odor development, it was trenched. No odors have emanated from the trenching field, which has been used for the past four years, and inspection of old trench material indicates that it is oxidizing readily. During the summer months all the screen trash was transported to an adjacent field and plowed under the surface once a week. Occasionally the piles of material awaiting final disposal were sprinkled with hypochlorite of lime to prevent odor and fly production. All of the material produced last fall was disposed of to a nearby gardener, who gladly hauled the material away after inspecting a test patch of corn, potatoes, beans, and curly cabbage which had been planted in ground in which screenings had been plowed the previously year.

TRICKLING FILTERS

The trickling filters operated satisfactorily in spite of the fact that the filter underdrains were submerged by rises in the river level on 89 days and by artificial flooding of the filters for psychoda control during 8 additional days.

During the winter a heavy surface film began to form and by spring this film was heavy and black. A 48-hour period of chlorination at the rate of about 25 parts per million cleared all of the filter units. Chlorination was not repeated during the entire summer but the film did not develop unduly. No sign of any surface pooling was detected during the entire twelve months and the physical condition of the surface media was excellent.

"A prolific life development was found in the beds during the year. Spiders were more prevalent that ever and treatment of the beds for film removal and fly control had no apparent effect on the filter worms. Archorutus viaticus increased in numbers and they appeared to be distributed more evenly over the six beds than was the case when they first began to develop here. An interesting attempt was made to distribute these insects more evenly over the three acres of beds when myriads of them were floated to the surface of the sewage used to float the units. They were skimmed into large metal baskets, stored to prevent their death during the period of flooding, and then sown into the siphon chambers and thus distributed over the bed area. Archorutus viaticus thrived despite the flooding operations and they may eventually be an active agency for improved bed maintenance.

"Psychoda inhabited the beds in small numbers throughout the winter and increased in numbers early in the spring. Chlorination temporarily controlled their development during the early spring months. The beds were flooded for twenty-four-hour periods on eight occasions from May to October and the flies were thus kept under satisfactory control. A short 4-hour period of bed flooding was tried in September. The secret of effective fly control seems to be the application of control measures at very frequent intervals, but flooding more often than twice a month reduces filter efficiency. The Schenectady effluent suffered marked reductions in stability that lasted usually for 7 days after bed submergence. Auxiliary fly control was practiced by spraying with kerosene and dilutions of Phinotas oil."

In order that important outdoor work can be carried on during the night as well as day and the plant kept in better condition, eight novalux lights have been installed about the tanks and filters.

## Sewage Problems in California

California has some conditions affecting its sewage problems which are peculiar to the state. There are great variations in rainfall, definite rainy and dry seasons, irregular stream flow, relatively high temperature, and a seasonal character of many of its industries, all of which complicate the disposal problem. Increasing use of recreational beaches emphasizes the difficulties of ocean disposal without menacing the health of bathers or fouling the sands. The great variety and large quantity of industrial wastes make their treatment in combination with domestic sewage extremely difficult, owing to the large amount of organic matter and the detrimental effect of some of the chemicals used.

The problem connected with industrial wastes is not one of the large cities only. Canneries, pickle works, creameries, wool scouring plants, tanneries, slaughter houses and rendering works, gas plants, oil refineries, soap works, sugar refineries, industrial alcohol plants and other industries are located not only in large industrial centers but also in the smaller towns. This presents the problem of developing methods of sewage treatment which will be reasonable in cost and will produce satisfactory results.

Because of these conditions, it is felt by a number of the sanitarians of that state that solutions that have proved practicable elsewhere may not prove to be so in California. Standards of designs for treatment plants which have been accepted in the East have not been found uniformly satisfactory in that state. They believe, therefore, that a thoroughly practical study of different methods of treating and disposing of the sewage of the state and its industrial wastes is immediately necessary.

Such a study would logically include a general survey of the state to locate places where the problems

are typical; second, the installation of practical, working-size experimental treatment units; third, the operation of these units over a sufficient period of time to gather the facts required; fourth, laboratory studies of special phases of sewage treatment prior to their being tried out in the experimental plants; fifth, cooperative studies of the operations of various industries to determine whether some of their present waste products can be utilized, thus reducing the amount of material to be treated; sixth, the carefully controlled operation of certain existing sewage treatment plants to obtain basic data of general interest; seventh, the digestion and comparison of the facts obtained, and the publication of the data with appropriate recommendations.

Impressed with the importance of these facts, many of the sanitarians are working with a view to securing from the state legislature adequate support of the Bureau of Sanitary Engineering of the State Board of Health, which will permit it to carry on the investigations above outlined. A committee of the League of California Municipalities has the matter in hand and is preparing a draft of the legislation necessary.

# Report on New York's Sewage Disposal

**Recommends construction in East River of activated sludge plant of two hundred and forty million gallons capacity, fertilizer to be manufactured from the sludge.**

The Board of Estimate & Apportionment of New York City on May 10 received the report of George W. Fuller, the consulting engineer on the proposed Ward's Island sewage treatment plant, and referred it to a special committee charged with responsibility for this project, consisting of the comptroller, the president of the Borough of Manhattan, and the chief engineer of the board, Arthur S. Tuttle. Mr. Fuller did not prepare detailed plans of the project but was asked to give his advice on certain questions connected with the proposed plant. His report on this, which will be one of the largest purification plants in the country, will be of general interest.

Mr. Fuller was asked what process of treatment should be used which could be placed on the 50 acres available on Ward's Island, and, under the treatment recommended, what mean and maximum volumes per day could safely be taken care of. If the activated sludge treatment be selected, what assurance is there that odor would not be produced that would be objectionable to inmates of the institutions on the island or even to the inhabitants of more remote areas? Also, whether preliminary investigations should be made to determine the general features of the plant, such as gaugings to determine the flow of main tributary sewers, analyses to determine character of sewage, experiments to determine whether to use fine screens or tanks, and the type of tank; the method of aeration—whether diffusion or mechanical agitation; whether and where the sludge should be digested, dewatered or dried; and possible utilization of the gases from digestion of sludge.

He was also asked concerning the preparation and drying of sludge for sale as fertilizer and for other disposition which could possibly be made of the sludge. Also, should grit chambers be installed on the mainland before the sewage enters the syphons leading to the island.

The site of the proposed disposal plant, Ward's Island, lies in the East river near the upper end of Manhattan Island, and the effluent would have to pass between the boroughs of Manhattan and Brooklyn on its way to the harbor. It was therefore considered necessary by Mr. Fuller that all floating matters, grease and oil, which would cause nuisance to the eye, should be removed from the sewage, as should all solids capable of settling and forming sludge banks. In addition, it is highly important that the putrescible organic matter in the tributary sewage be eliminated as completely as possible.

He highly recommended the adoption of the activated sludge process, considering it the only method which can be installed on the area available on Ward's Island, which will effectively remove the polluting matter, and can operate at this location with full assurance of freedom from nuisance. Room is not available for the use of sprinkling filters, in addition to which they would probably produce some local nuisance from odors and perhaps from flies.

While the 50 acres would readily accommodate an activated sludge plant with sludge dewatering arrangement capable of treating 180,000,000 gallons daily on the average and a maximum 50 per cent. greater, he did not consider it advisable to locate the dewatering arrangements at Ward's Island, but recommended that these be located elsewhere and that the additional area be devoted to installing a plant with a total capacity of at least 240,000,000 gallons daily average flow. This would provide for the sewage from substantially all territory in Manhattan and the Bronx tributary to this site until about 1950.

As to nuisance, he states that the activated sludge process would give off no odors. A portion of the tributary sewage may be stale and undergoing putrefaction when it reaches the plant, but the mixture of sewage need not be expected to develop odors during the preliminary treatment before reaching the aeration tanks, although if necessary it is entirely feasible to control such conditions by means of chemicals or special aeration.

For preliminary treatment, he recommends fine screens as at Milwaukee, or preliminary settling tanks with a detention period of about 30 minutes as at the North Side Chicago Works; stating that the latter will do the same work as the fine screens at no greater cost and at the same time will prove helpful for separating out much of the oil and grease from the sewage. Detailed study may show the wisdom of install-

ing preliminary settling tanks with perhaps a one-hour detention period so that a substantially complete removal of settleable solids can be obtained. This will substantially reduce the total volume of wet sludge produced and also the cost of air for activation of the sewage.

Discussing the matter of the method of aeration, Mr. Fuller says: "Aeration by spiral flow induced with compressed air will in our judgment prove most economical and advantageous. No experiments are needed to determine the relative advantages of mechanical agitation versus air diffusion, as adequate data are available to permit the proper determintion of this question when it comes to the design of the plant. Spiral flow secures the maximum amount of mixing and overturning to give exposure to the air with a minimum amount of power for compressing air." At Essen, Germany, both mechanical agitation, as by paddle wheels or propellers, and compressed air are used in combination.

An activated sludge plant treating 180 million gallons of sewage daily would produce 5,000 to 7,000 tons of wet sewage in 24 hours. This could be disposed of by dewatering and then drying for use as a fertilizer, or by shipping to sea in steamers without de-watering. Digesting the sludge in either Imhoff tanks or separate sludge digestion tanks was looked into but was not considered economical or advisable for this location. Whether the sludge be dewatered and dried for fertilizer, or be shipped to sea in steamers without dewatering, it was considered advisable to pump it through a pipe line to a point accessible to steamers drawing at least 16 feet of water; not only because land is not available for installing a plant on Wards Island, but the manufacture of fertilizer there might give rise to odors.

Based on the operating experience at Milwaukee and at Pasadena, Mr. Fuller believes it perfectly practicable to manufacture a fertilizer from activated sludge, and to do so at a cost of $2,700,000 for construction and about $946,300 annually for operation and maintenance, if for sludge from the whole 180,000,000 gallons per day; or $1,000,000 for construction and $398,300 for operation and maintenance, if only one-third of it be so treated.

While Milwaukee receives only about $15 per ton for her sludge, on account of having to ship most of it to the cotton belt for sale, the selling price there is about $22.00. Comparing the cost of preparing the fertilizer with that of shipping the wet sludge to sea, he states that if the fertilizer made can be sold for about $16 per ton, the net cost of treatment will be no greater than if the sludge were disposed of by shipping to sea. Any income over $16 per ton would be a profit, but if the return should average less than that, it would make this method more expensive than shipping to sea. If it could be sold at $20 per ton, since there would be an annual production of 55,000 tons of fertilizer, this would mean a saving of $220,000 annually over sea disposal.

There are certain advantages in sea disposal. It is practiced abroad by London, Glasgow, Manchester and Dublin; and by Providence, R. I. and the Passaic Valley Sewerage System in this country. It would mean a saving of about $2,000,000 in construction cost, and the net cost is not dependent upon operating efficiency of a fertilizer plant or uncertainties regarding the future market and sales for fertilizer.

Whichever method of disposal be adopted, it is proposed to pump the sludge a distance of 15 miles through a 16-inch pipe, which could be laid in existing streets along a fairly direct route. In crossing from the island to the mainland, if the pipe could be laid on the Hell Gate bridge it would save considerable expense and trouble. If not, it would probably be necessary to tunnel under the river to Astoria, the same tunnel to be used for the pipe delivering the sewage from the naturally tributary portion of Queens for future treatment on the island.

It will be necessary to provide grit chambers and coarse bar screens at the entrances to the pressure tunnels leading to Wards Island and also at all entrances to any other pressure tunnels which may be found advantageous, in order to guard against the clogging of the tunnels by accumulations of grit and other materials. The grit chambers should be provided with suitable mechanical arrangements for cleaning them economically but it would be necessary to have operators at each grit chamber to see that they were always maintained in proper working condition.

"Sewage regulators will be needed at each combined sewer which is intercepted, in order to control the flow of dry-weather sewage into the interceptor and shut out excess flows during times of storms. There are numerous types of such regulators and the best arrangement for each given sewer must be determined in the detail design of the works. Regulators properly designed and constructed can be made reasonably satisfactory in operation but from their nature require careful maintenance and frequent inspection to insure that they are in working order at all times. In the case of certain of the larger sewers it will doubtless be advisable to have operators constantly on duty at the regulator chambers."

The cost of the Wards Island treatment plant is estimated at $15,950,000. The sludge line for pumping the sludge to tide water, and a storage tank and wharf is estimated at $840,000. The sludge steamers are estimated to cost $710,000. A fertilizer plant of 50 tons daily capacity is estimated as $1,000,000 and $2,700,000 for a 150-ton plant. These amount to $18,500,000 as the total construction cost on the basis of a 50-ton fertilizer plant with 100 tons per day shipped to sea, and $19,490,000 with all sludge made into fertililizer.

In estimating the annual cost, he allows 5 per cent. for fixed charges (which seems to be very little to cover depreciation and obsolescence); to which is added $235,600 a year for pumping the sludge. The cost of operation and maintenance of the activated sludge plant is estimated at $790,750 a year; of the 50-ton fertilizer plant at $398,300, and shipping 100 tons to sea $135,000.

This gives a total annual cost of $31.51 per mil-

lion gallons if all sludge is shipped to sea; $44.86 per million gallons if all is manufactured into fertilizer; and $37.82 if 50 tons per day is manufactured into fertilizer and the balance is shipped to sea.

To this is credited fertilizer at the rate of $20 per ton, giving a credit of $16.74 if all the sludge is manufactured into fertilizer and $5.56 if one-third of it is so manufactured.

This gives net annual cost as follows: All sludge shipped to sea $31.51; all sludge manufactured into fertilizer $28.12; 50 tons into fertilizer the balance shipped to sea $32.26.

# Bulking of Activated Sludge

**English investigation indicates it is due to constituents of the sewage and not to under or over aeration.**

At a recent meeting of the Association of Managers of Sewage Disposal Works of England, a paper was read by Walter Scott, chemist of the Bury Corporation sewage works, describing the result of an investigation into the cause of bulking of activated sludge. Although many observers have attributed this phenomenon to either under-aeration or over-aeration, he believes that it is due to neither of these but rather to some characteristics of the sewage itself. He said, "Increased aeration has not the slightest effect on checking bulking. In fact, it seems to emulsify the sludge and render the effluent cloudy.

On a large scale experiment with separate aerting and settling areas, he experienced periodic bulking, although there were no indications of stagnation and generally there was plenty of dissolved oxygen in the aerating and settling areas. So it was obvious that bulking was not due to stagnant sludge. From the evidence obtained in his experiments he has come to the conclusion that bulking is due to the nature of the sewage undergoing treatment or rather to the presence of certain substances in the sewage.

He did not pretend to designate just what these substances might be, but did describe positive bulking results obtained by injection into sewage of either milk, starch or brewery waste.

He first experimented by taking daily samples of washings from milk cans and, starting with 17% of activated sludge from the aerating tanks, he decanted the supernatant liquor to sludge level and filled up the receptacle with a fresh charge of the milky water. Aeration was continued for 22 hours and sludge reading taken daily after one hour's settlement. In six days the volume of sludge increased from 17% to 30%, while a sample of milk washings aerated continuously for six days without changing the sample increased from 17% to 24%.

When the sludge reached 30% Mr. Scott began taking out small quantities of effluent and replacing by the same volume of washings of milk cans containing no suspended matter and gradually increased the amount decanted off and replaced with a view to acclimatising the sludge. Operating in this manner, the volume of sludge increased in six days from 34% to 90%.

The experiments were repeated on sludge prepared by treating daily samples of milky water for about one month in order to make sure of operating on actual milk sludge. In five days the volume of sludge increased from 27% to 70%, while a sample of milky water aerated continuously for five days with a similar amount of the above sludge increased from 23% to 28%.

Similar experiments were carried out by aerating aqueous solutions containing 1% starch in the form of starch paste. In six days there was an increase in volume of sludge from 6% to 24%, and in another case the increase was from 14% to 24% in five days and to 95% in 10 days.

Another series of experiments was undertaken by adding colloidal substances such as milk or starch to samples of sewage. One sample was used as received, to another milk was added equal to 1%, and to the third, starch paste equal to 1%. "Each sample was aerated for one day (starting with activated sludge taken from the aerating area of our activating tanks) and the volumes of sludge read off each morning after one hour's settlement. After taking the sludge readings, the effluents were decanted off to sludge level, and then made up to 500 cc. again with the respective sewages with and without milk and starch. This operation was repeated daily" for 28 days. By the 17th day the sewage only had increased from 14% to 18%, that to which 1% milk had been added increased from 13½% to 47½%, and that containing starch from 13% to 86½%. On the 17th day the starch sludge was reduced to 18% and on the 19th day the volumes of milk sludge was reduced to 19%, and by the 27th day, while the original volume of sludge from plain sewage had increased to only 20½%, the reduced volume containing milk and that containing starch had increased from 19% and 18% respectively to 95%.

These and other experiments led the author to conclude that bulking is due to the presence of certain substances in sewage, and not to under or over-aeration.

Investigating some of the wastes found in the sewage of his borough, Mr. Scott decided that tannery waste has no effect on bulking.

Using brewers' yeast and sugar, one grain of each to 500 cc. of domestic sewage, and aerating, the volume of sludge increased from 10% to 79% in 8 days. The addition of yeast only did not at first give rise to such pronounced bulking as when combined with sugar, but eventually the bulking became very pronounced.

## Garbage Disposal in Newton, Massachusetts

In Newton, Massachusetts, which in 1927 had a population of 56,608, garbage is collected and disposed of by contract. The 1927 figures show that 292.2 pounds per capita of garbage was collected, or

a total of 8,271 tons during the year; an increase of 605 tons over 1926, or about 7.8%.

Garbage is collected daily from stores, schools, restaurants and hotels; and from residences and other places twice a week.

The work is performed by John A. Janse under a contract which began October 1, 1927, and expires September 30, 1930. Mr. Janse purchased all new equipment, consisting of trucks with tarpaulin covers and water tight bodies. The street commissioner, George E. Stuart, to whom we are indebted for this information, informs us that this equipment is very satisfactory to the city and that the contractor cooperates with the city in every way and complies with all requirements and regulations. The contractor removes the garbage from the city immediately upon collection and sells some of it to farmers while the rest is fed to hogs; the income from this, of course, belonging to the contractor.

The city appropriated $52,200 for garbage collection and disposal in 1927 and expended $52,-174.87, which gives a cost of $6.31 per ton for collection and disposal.

# Street Cleaning in Toledo

**Survey of city's methods and practices, with recommendations for improving organization, equipment and financing.**

A survey of street cleaning methods and practices in Toledo, Ohio, has been made and published by the Commission of Publicity and Efficiency of that city in its weekly publication, the "Toledo City Journal." This survey apparently has received favorable consideration by the city officials for, following the publication of the first instalment of the report on April 14th, the second instalment stated that the street commissioner, during the week between the two, had already put into effect three of the five recommendations that had been made.

The recommendations made in this report were: That 17 temporary employees in the street division office be required to take civil service examinations, as required by the city charter; that the clerks and inspectors who are listed as laborers, class B, be placed in the classified service; that an inspector be employed to make a careful check-up of the effectiveness and amount of street cleaning done under the different foremen, each foreman at that time being his own inspector; that an up-to-date cost record system be installed and the unit cost of street cleaning per thousand square yards for each method of cleaning be determined, so that the property owner may see what work is done for the money expended; that there be a careful check on the distances reported cleaned and the actual length of streets reported cleaned, there being at that time no check on the foremen's reports and inaccuracies amounting to 23% having been found for the month of July, 1926; that the city purchase at least one or two flushers; that the number of laborers be considerably reduced, partly by substitution of mechanical equipment for hand cleaning; that all streets be cleaned at least once every two weeks during the cleaning season; that careful checks be made of costs as reported by different officers; and that street cleaning be financed by general taxation instead of by special assessment, as at present.

### ORGANIZATION AND PERSONNEL

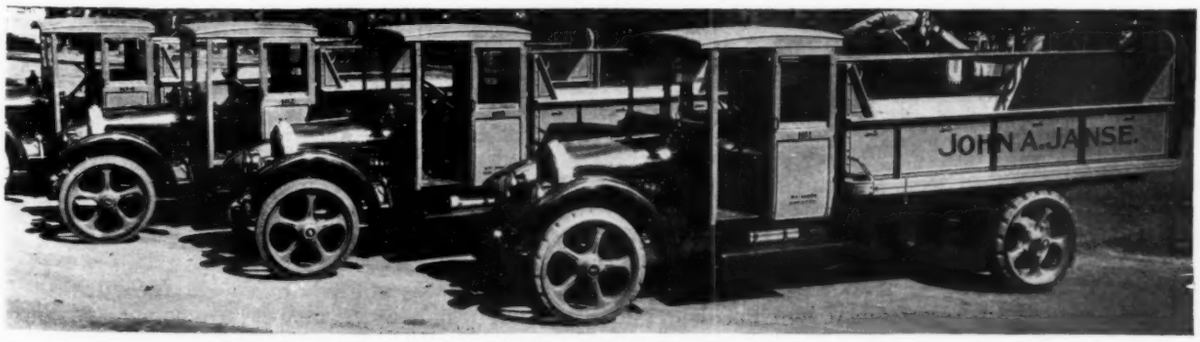
In Toledo the Division of Streets in the Department of Public Service repairs streets, collects garbage, cleans sewers, and cleans streets. The street commissioner is responsible to the Director of Public Service, and under him are a general foreman of street cleaning and a foreman of cleaning and repair on the east side. There are four other foremen under the general foreman.

The city is divided into ten districts for the purpose of street cleaning.

Four machine sweepers are used by the city, operated by crews of two men each, and in addition there are six men who collect the refuse dumped by the sweepers. The white wing division averages about 29 men, employed in cleaning and pick-up work in the business district and a few residential streets. In 1927 an average of 100 men were working at street cleaning. Nine men are used in catch basin cleaning and 10 to 15 drive hired trucks. Eighteen of the positions are in the classified civil service, while the others are classed as unskilled laborers.

### RECORDS

Each foreman makes a daily report of the work done, giving on one side of the report sheet the cost of labor, of hired trucks, of cleaning catch-basins and of weed cutting; and the loads of rubbish removed, linear feet of street cleaned and gallons of water used; while on the opposite side of the report are the names and lengths of the streets cleaned. All classes of cleaning, such as flushing and machine cleaning, are reported together. It was recommended that figures be given for each kind of cleaning sep-




GARBAGE COLLECTION TRUCKS USED IN NEWTON, MASS.

arately; also that the area cleaned be given in square yards rather than in linear feet of street; moreover, that the linear feet of street be checked, a check on eight districts for the month of July, 1926, having discovered a difference between the reported linear feet cleaned and the actual distance cleaned as indicatd by the street named, to be as great as 23%.

### METHODS AND EQUIPMENT

Concerning methods and equipment, the reports state that Toledo cleaned over half of her streets in 1926-1927 by the slowest and most expensive method—hand cleaning. The city possesses very little mechanical equipment and its unit cost was five times as high as the average of seven other cities of similar size. The city should have twice as much mechanical equipment as it has, and the purchase of at least one or two flushers was recommended, "Since the experience of other cities shows flushing to be the most economical as well as satisfactory method of street cleaning."

Not only is hand cleaning unnecessarily expensive, but there has been an unnecessary number of employees on the payroll.

The streets in the outlying district of the city are not cleaned more than ten times in a season, and it is recommended that all streets be cleaned at least once every two weeks during the cleaning season.

Last year 41.3% of the mileage of cleaning was done by pick-up machine sweepers and flushers, 20.3% by white wings and 38.4% by hand cleaning. For sewer cleaning, the city used a combination sewer eductor and street flusher, and a separate sewer eductor. The greater part of the refuse was collected by hired trucks, from ten to fifteen trucks being used at the rate of $1.00 per hour for truck and driver. The street commissioner believes that it is cheaper for the city to hire private trucks at this price than to pay for new trucks, maintenance, upkeep and drivers of its own.

The street commissioner seems to think that flushing would not work well in Toledo because the sewers are not large enough to carry the dirt washed from the streets. The investigators, however, believe that a considerable part of the streets of the city can be cleaned this way to advantage. They state that in Kansas City a saving of 35% to 40% was made by using street flushers instead of hand cleaners, and that Detroit reports that flushing costs only 27% as much as machine cleaning and 15% as much as hand cleaning per unit of street cleaned. Also flushers can clean under standing vehicles while machine sweepers can not.

By means of a questionnaire, information has been obtained concerning the use of street cleaning equipment in Akron, Cincinnati, Columbus, Cleveland, Dayton, Indianapolis, Kansas City, Mo., Portland, Ore.; Rochester and St. Paul. Of these, Akron has 7 motor sweepers, Cleveland 10, and none were used in the other cities. Of flushers, however, every city had from 1 to 18, Cleveland having the larger number and Dayton the smaller. The report states that machine sweepers are very satisfactory in picking up the refuse from smooth streets, but when used on rough streets they must have new stiff brushes in order to get down into the depressions to remove the dirt, as a result of which new brushes are generally used for the rough streets and turned on to the smoother ones as they wear down.

The distinction made in the report between "hand cleaning" and "white wing cleaning" is that the latter is a special cleaning used in addition to machine cleaning and flushing. Sixteen men are employed regularly in white wing cleaning of the business section, and 7 on residential streets. It was reported that in 1927, 2,700 miles of cleaning was done by hand cleaners, and 1,425 miles by white wings. Aside from the business streets, which were cleaned daily, the other streets probably averaged about ten cleanings a year.

### COSTS

Discussing the matter of costs, the report states that the unit cost of cleaning in 1925 was $2.48 per thousand square yards, $3.30 in 1926, and $2.52 in 1927; the average cost in seven other cities having been 50c. This high cost is attributed largely to the use of hand labor instead of machine methods.

The per capita cost of street cleaning has declined from $1.51 in 1921 to 92c in 1926 and 98c in 1927. The average per capita cost of the ten cities investigated in 1926 was 61c. The cost per cubic yard of material removed was $4.90 in 1926 and $3.72 in 1927; and the cost per thousand square yards of cleaning done was $3.30 in 1926 and $2.52 in 1927.

The figures available indicated that in 1926 hand cleaning cost $3.97 per thousand square yards and machine cleaning $2.30; while in 1927 the costs were $3.28 and $1.32 respectively.

These costs are based on the toal assessed cost, which is supposed to include total cost of labor, maintenance, supplies, contractual services, and outlay for new equipment; plus 10% interest charges on the two-year notes issued at 5% per year plus one per cent for assessment charges (explained below).

### FINANCING

The high cost in Toledo was partly due to the special assessment method of finance, which adds 11% to the actual cost of street cleaning because of the issuance of two 5% notes to finance the cleaning and a 1% overhead charge. (A two-year note is necessary for financing the assessment, since the cost of street cleaning is not determined until the tax bills have been made up for the following year and the assessment charge is placed on the tax bill.) Moreover, most of the other cities reported do not include the cost of weed cutting and catch-basin cleaning in the cleaning cost, which would add 6% to 10% to the cost of cleaning in the other cities if included.

The report states that if street cleaning had been financed by general taxation in 1927 it would have saved the citizens over $28,500. The committee therefore recommended that the city finance its street cleaning by general taxation.

At present the street cleaning is financed by assessing the cost on the properties abutting the paved streets according to their front footage, the entire front footage of corner lots being reduced by one-fourth for assessment purposes. This method of financing was started in Toledo several years ago through inability to finance all current activities by general taxation.

The assessments are made on a cost basis. At the end of the year the total cost of cleaning each district (including interest assessment charges and overhead of 11%) is determined from the records of the Street Division of the Bureau of Licenses and Assessments. This amount is divided by the total length of the assessible property abutting the pavement (after deducting for corner lots) to determine the cost per front foot. In 1925 the cost per front foot varied from 5.7c in District Three to $1.19 in District Four—the business section. In 1926 the variation was from 6.9c to 58c, and in 1927 from 6.9c to 93c. Some of this great variation is probably due to the daily white-wing service in the downtown district.

It is stated that this method of assessment by no means distributes the cost according to benefit received. For instance, a person living on an unpaved street pays nothing for cleaning although he uses the cleaned and paved streets and his children may play on them. The owners of business property pay 21 times as much as property owners on paved streets in other districts, who receive the benefit of clean business streets during their shopping. Moreover, the person whose street is cleaned ten times a year pays as much as one whose street is cleaned twenty times a year if he lives in the same district.

If street cleaning were paid by taxation, the cost would be apportioned according to ability to pay as measured by ownership of property. However, the greater share of the burden would still fall upon the property owners on paved streets, since their property is generally assessed higher than that on non-paved streets. The principal argument for payment by taxation seemed to be the saving of 11% of the cost.

# Water Works in 1927

**Information furnished by several hundred cities giving lengths of the different kinds of pipe laid, number of hydrants, valves and meters placed, and kinds of pumps used.**

Through information collected from water works officials during the past six weeks, PUBLIC WORKS presents its seventeenth annual survey and summary of water works activities in United States and Canadian cities.

The value of such data is attested by the fact that the demand for them has persisted, and has increased steadily, for seventeen years. So far as we know, there is no other agency which collects and furnishes such up-to-date information.

In collecting this information, it is not possible, nor is it desirable, to cover the entire field of water works each year. Instead, the aim is to provide latest information on topics of interest, and to give a "perpetual inventory," so to speak, of water works practice. Many requests for such information reach us from time to time and we are glad to be able to answer them completely and promptly and to share the credit with water works officials who have so kindly aided us in collecting the information. We take this opportunity of expressing our appreciation of their assistance.

## Cast Iron Pipe Laid in 1927

| City and State | Plant Municipal or Private | Under 6-inch | 6, 8, 10 and 12-in. | Over 12-inch |
|---|---|---|---|---|
| **Alabama:** | | | | |
| Gadsden | M | .... | 11,000 | .... |
| **Arkansas:** | | | | |
| Fort Smith | M | .... | 1,825 | .... |
| **California:** | | | | |
| Fresno | P | 601 | 834 | .... |
| Modesto | M | 2,033 | 3,653 | .... |
| Monterey, Pacific Grove, Carmel, etc. | P | 80,601 | 8,499 | .... |
| Santa Barbara | M | 7,500 | 40,000 | 500 |
| **Colorado:** | | | | |
| Greeley | M | 3,452 | 2,269 | .... |
| **Connecticut:** | | | | |
| Bridgeport | P | 1,000 | 43,700 | 27,123 |
| Danielson | P | .... | 1,070 | 3,225 |
| Groton | M | .... | 310 | .... |
| Hartford | M | 34 | 54,685 | 493 |
| Naugatuck | P | .... | 1,489 | .... |
| Norwich | M | 760 | 2,965 | .... |
| Putnam | M | .... | 132 | .... |
| Southington | M | 8 | 3,177 | .... |
| Torrington | P | .... | 3,000 | .... |
| **Florida:** | | | | |
| Lakeland | M | .... | 43,000 | .... |
| Orlando | M | 16,000 | 5,000 | .... |
| Palm Beach | P | .... | 59,011 | 9,623 |
| **Georgia:** | | | | |
| Albany | M | 1,400 | 13,500 | .... |
| Atlanta | M | 77 | 110,890 | 27,125 |
| Augusta | M | 8,160 | 1,150 | .... |
| Thomasville | M | 2,000 | 10,400 | .... |
| **Illinois:** | | | | |
| Brookfield | M | .... | 10,500 | .... |
| Carbondale | M | 2,000 | .... | .... |
| Edwardsville | P | 3,894 | 2,309 | .... |
| **Illinois** (Continued): | | | | |
| Evanston | M | .... | 11,954 | .... |
| Farmington | M | 700 | .... | .... |
| Pekin | P | .... | 414 | 2,734 |
| Quincy | M | .... | 6,812 | .... |
| Rock Island | M | .... | 9,440 | .... |
| Staunton | M | 4,000 | .... | .... |
| Sterling | P | .... | 5,200 | .... |
| Zion | M | .... | 37,000 | .... |
| **Indiana:** | | | | |
| Boonville | M | 700 | .... | .... |
| Columbia City | M | 205 | .... | .... |
| Elkhart | M | .... | 55,000 | 4,500 |
| Fort Wayne | M | .... | 63,535 | 120 |
| Indianapolis | P | .... | 105,372 | 1,491 |
| Lebanon | M | .... | 2,400 | .... |
| Muncie | P | 14,360 | 5,200 | .... |
| Mishawaka | M | .... | 32,719 | 1,320 |
| New Albany | P | 1,400 | 6,500 | .... |
| Richmond | P | .... | 9,116 | .... |
| Seymour | — | .... | 350 | .... |
| West Lafayette | P | 200 | 5,000 | 1,200 |
| **Iowa:** | | | | |
| Burlington c | P | 2,915 | 6,586 | 3,838 |
| Creston | P | 1,000 | .... | .... |
| Des Moines | M | .... | 16,390 | 3,405 |
| Dubuque | M | 1,301 | 7,963 | .... |
| Fairfield | M | .... | 12,385 | .... |
| Hawarden | M | 1,200 | .... | .... |
| Mason City | M | 1,000 | 6,000 | .... |
| Oskaloosa | M | 10,000 | 10,000 | .... |
| Red Oak | M | 2,000 | .... | .... |
| Sioux City | M | 2,362 | 42,604 | .... |
| **Kansas:** | | | | |
| Dodge City | M | 12,000 | 9,500 | .... |
| Lawrence | M | .... | 1,200 | .... |
| Horton | M | 1,000 | 6,000 | .... |
| **Kentucky:** | | | | |
| Louisville | M | 6,332 | 170,076 | 40,623 |

# Cast Iron Pipe Laid in 1927

| City and State | Plant Municipal or Private | Under 6-inch | 6, 8, 10 and 12-in. | Over 12-inch |
|---|---|---|---|---|
| **Maine:** | | | | |
| Houlton | Pa | 517 | .... | .... |
| **Maryland:** | | | | |
| Frederick | M | 2,000 | .... | .... |
| Hagerstown | M | .... | 6,400 | .... |
| Salisbury | M | .... | 67,300 | .... |
| **Massachusetts:** | | | | |
| Amesbury | M | .... | 7,500 | .... |
| Athol | M | .... | 4,252 | .... |
| Beverly | M | .... | 4,607 | 1,639 |
| Brockton | M | 5,490 | 13,865 | .... |
| Cambridge | M | 173 | 3,635 | .... |
| Clinton | M | 4,079 | 3,772 | .... |
| Danvers | M | 738 | 3,230 | .... |
| Fairhaven | P | .... | 2,619 | .... |
| Fitchburg | M | 2,037 | 4,506 | .... |
| Framingham | M | 100 | 13,154 | .... |
| Greenfield | — | .... | 16,425 | .... |
| Haverhill | M | 340 | 4,256 | 4,395 |
| Holyoke | M | .... | 3,070 | 33,095 |
| Lenox | P | 4,000 | .... | .... |
| Maynard | M | 427 | 461 | .... |
| Melrose | M | .... | 7,973 | .... |
| Milton | M | 1,522 | 15,143 | 28 |
| New Bedford | M | .... | 5,550 | .... |
| Newburyport | M | .... | 3,394 | .... |
| Northampton | M | 128 | 15,687 | .... |
| North Adams | M | .... | 2,062 | .... |
| North Andover | M | .... | 2,344 | .... |
| Saugus | M | .... | 12,270 | .... |
| So. Hadley Falls. | M | .... | 1,300 | .... |
| Spencer | M | 19 | 3,150 | 6,008 |
| Springfield | M | .... | 14,553 | 1,829 |
| Ware | M | .... | 2,230 | .... |
| Webster | M | .... | 4,297 | .... |
| Winthrop | M | 173 | .... | .... |
| Worcester | M | 26,000 | 24,000 | 3,500 |
| **Michigan:** | | | | |
| Charlotte | M | 5,297 | 856 | .... |
| Coldwater | M | 300 | 2,500 | .... |
| Detroit | M | .... | 870,068 | 94,938 |
| Escanaba | M | .... | 400 | .... |
| Gladstone | M | .... | 600 | .... |
| Hastings | M | 120 | 360 | .... |
| Holland | M | 245 | 8,188 | .... |
| Jackson | M | 285 | 13,262 | .... |
| Lapeer | M | .... | 1,800 | .... |
| Monroe | M | .... | 7,767 | .... |
| Niles | M | 3,743 | 12,174 | .... |
| Petosky | M | 8 | 358 | .... |
| Saginaw | M | 270 | 18,750 | 2,450 |
| St. Johns | M | 400 | .... | .... |
| St. Joseph | M | 5,000 | 3,000 | .... |
| Traverse City | M | .... | 5,000 | .... |
| **Minnesota:** | | | | |
| Cloquet | M | .... | 2,544 | .... |
| Duluth | M | .... | 16,547 | 14,203 |
| Ely | M | 5,040 | 6,229 | 500 |
| Hibbing | M | .... | 2,043 | .... |
| Internation. Falls. | P | .... | 1,000 | .... |
| Minneapolis | M | .... | 31,000 | .... |
| Moorhead | M | .... | 7,978 | .... |
| **Mississippi:** | | | | |
| Jackson | M | .... | 50,000 | 46,000 |
| Natchez | M | 8,000 | 3,000 | .... |
| **Missouri:** | | | | |
| Joplin | P | .... | 6,420 | .... |
| Sedalia | P | 660 | 6,500 | .... |
| **Montana:** | | | | |
| Billings | M | .... | 5,224 | 4,305 |
| Kalispell | M | 280 | 4,050 | .... |
| **Nebraska :** | | | | |
| Fairbury | M | 1,020 | .... | .... |
| Fremont | M | .... | 1,100 | .... |
| Grand Island | M | .... | 8,000 | .... |
| Lincoln | M | .... | 95,832 | .... |
| Nebraska City | P | 5,040 | .... | .... |
| Scotts Bluff | M | 6,350 | 6,500 | 150 |
| Sidney | M | 700 | .... | .... |
| **New Hampshire** | | | | |
| Lebanon | M | .... | 1,500 | .... |
| Manchester | M | 333 | 12,181 | 4,566 |
| Rochester | M | .... | 300 | .... |
| **New Jersey:** | | | | |
| Belleville | M | .... | 6,084 | .... |
| Clifton | M | .... | 2,118 | .... |
| Glen Ridge | M | .... | 10,225 | .... |
| Irvington | P | .... | 14,893 | 3,545 |
| Newark | M | 195 | 62,378 | 6,641 |
| Plainfield | P | .... | 72,720 | .... |
| Red Bank | — | 1,000 | .... | .... |
| **New York:** | | | | |
| Binghamton | M | 600 | 8,000 | .... |
| Gloversville | M | .... | 1,525 | .... |
| Hudson | M | .... | 6,000 | .... |
| Ithaca | M | .... | 10,000 | .... |
| Johnson City | M | 4,943 | 1,270 | .... |
| Little Falls | M | .... | 200 | .... |
| Mechanicsville | M | .... | 21,000 | .... |
| Mt. Vernon | M | 5 | 24,752 | .... |
| No. Tarrytown | M | .... | 1,900 | .... |
| Norwich | P | 360 | .... | .... |
| Ossining | M | .... | 4,763 | .... |
| Peekskill | M | .... | 4,000 | .... |
| Port Jervis | P | 541 | 1,991 | .... |
| Salamanca | M | 350 | 7,480 | .... |
| Tarrytown | M | 103 | 5,077 | .... |
| **North Carolina:** | | | | |
| Asheville | M | 1,006 | 46,355 | 44,776 |
| Greensboro | M | .... | 30,000 | 3,500 |
| High Point | M | .... | 6,000 | .... |
| Rocky Mount | M | 800 | 7,000 | .... |
| **North Dakota:** | | | | |
| Fargo | M | .... | 5,028 | .... |
| **Ohio:** | | | | |
| Akron | M | 2,640 | 107,700 | 5,280 |
| Cincinnati | M | 897 | 121,869 | 14,491 |
| Cleveland | M | 2,141 | 101,835 | 1,414 |
| Columbus | M | 1,919 | 71,200 | 11,400 |
| Conneaut | M | 28,703 | 103,162 | 2,189 |
| Crooksville | M | 45,000 | 15,000 | .... |
| Defiance | M | 650 | 3,500 | .... |
| Delaware | P | 300 | 1,200 | .... |
| Lima | M | 136 | 400 | .... |
| Logan | M | .... | 2,000 | .... |
| Marietta | M | .... | 500 | .... |
| Piqua | M | .... | 5,200 | .... |
| Sidney | M | .... | 3,800 | .... |
| Sylvania | M | 1,200 | .... | .... |
| Warren | M | 2,276 | 20,186 | .... |
| Youngstown | M | 307 | 40,757 | 2,941 |
| **Oklahoma:** | | | | |
| Blackwell | M | 12,000 | 15,000 | .... |
| Norman | M | .... | 1,200 | .... |
| Vinita | M | 7,800 | 89,000 | .... |
| **Pennsylvania:** | | | | |
| Aliquippa | P | 11,722 | 27,469 | .... |
| Bethlehem | M | 36 | 26,000 | .... |
| Clearfield | P | 1,155 | 233 | .... |
| Freeland | P | .... | 600 | .... |
| Hamburg | M | 482 | .... | .... |
| Huntingdon | M | 600 | .... | 2,700 |
| Kittanning | P | .... | 225 | .... |
| Lehighton | P | 1,400 | .... | .... |
| Mount Union | M | 200 | 100 | .... |
| Reading | M | .... | 3,150 | .... |
| Sayre | P | 600 | 200 | .... |
| Shamokin | P | .... | 10,000 | 500 |
| Springdale | M | 2,073 | 556 | .... |
| **Rhode Island:** | | | | |
| East Providence | P | .... | 2,328 | .... |
| Westerly | M | 3,329 | 6,764 | .... |
| **South Carolina:** | | | | |
| Charleston | M | 4,227 | 4,564 | 15,135 |
| Columbia | M | .... | 28,360 | .... |
| **Tennessee:** | | | | |
| Dyersburg | M | .... | 4,000 | .... |
| Jackson | M | 13,200 | 18,480 | .... |
| Knoxville | M | 1,400 | 74,100 | 8,100 |
| **Texas:** | | | | |
| San Antonio | M | .... | 63,000b | .... |
| Wichita Falls | M | 1,186 | 8,139 | 2,915 |
| **Vermont:** | | | | |
| Bellows Falls | M | .... | 2,000 | .... |
| Brattleboro | .. | .... | 3,500 | 4 |
| **Virginia:** | | | | |
| Fredericksburg | M | .... | 3,299 | 2,840 |
| Harrisburg | M | .... | 7,000 | .... |
| Salem | M | 500 | 4,000 | .... |
| Winchester | M | 5,569 | .... | .... |
| **Washington:** | | | | |
| Aberdeen | M | 4,000 | 8,000 | .... |
| **Wisconsin:** | | | | |
| Antigo | M | .... | 5,400 | .... |
| Baraboo | M | .... | 200 | .... |
| Fond du Lac | M | 4,575 | 10,957 | .... |
| Janesville | M | 179 | 17,500 | .... |
| Kenosha | M | 90 | 38,150 | 6,058 |
| Madison | M | .... | 6,000 | .... |
| Manitowoc | M | .... | 14,395 | 5,862 |
| Menasha | M | 4,508 | 3,492 | .... |
| Milwaukee | M | .... | 221,456 | 45,673 |
| Plymouth | M | 36 | 370 | .... |
| South Milwaukee. | M | .... | 7,200 | .... |
| Watertown | M | 2,934 | 4,853 | .... |
| Wassau | M | .... | 10,210 | 1,848 |
| Whitewater | .. | 400 | 800 | .... |
| Wisconsin Rapids | M | .... | 1,585 | .... |
| **CANADA** | | | | |
| **Nova Scotia:** | | | | |
| New Glasgow | M | .... | 114,700 | 14,000 |
| Truro | M | .... | 3,800 | .... |
| **Ontario:** | | | | |
| Belleville | M | .... | 1,000 | .... |
| Kitchener | M | 1,033 | 6,574 | .... |
| Peterborough | M | 1,174 | 1,069 | .... |
| St. Catherines | M | 1,320 | 3,000 | 320 |
| Tillsonburg | P | 3,251 | .... | .... |
| **Quebec:** | | | | |
| Cap de la Madeleine | M | .... | 2,300 | .... |
| Joliette | M | .... | 2,993 | .... |
| Lewis | M | 325 | .... | .... |
| Rimouski | M | .... | 1,300 | .... |
| Sherbrooke | .. | .... | 2,035 | .... |
| Verdun | M | 5,400 | .... | .... |

a—Town owns the stock; b—includes pipe larger than 12-inch; c—city owns $175,000 of stocks and bonds of the company.

## Steel Pipe Laid in 1927

| City and State | Under 12-in. | 12-inch and over |
|---|---|---|
| **California:** | | |
| Anaheim | 119,000 | .... |
| Santa Barbara | .... | 8,500 |
| **Colorado:** | | |
| Greeley | 540 | .... |
| **Georgia:** | | |
| Thomasville | 4,300 | .... |
| **Illinois:** | | |
| Sterling | .... | 300 |
| **Massachusetts:** | | |
| Springfield | .... | 400 |
| **Michigan:** | | |
| Detroit | .... | 2,677 |
| Holland | 412 | .... |
| Saginaw | .... | 19,000 |
| **Minnesota:** | | |
| Minneapolis | .... | 117,865 |
| **Montana:** | | |
| Libby | 350 | .... |
| Missoula | 1,000 | .... |
| **Oregon:** | | |
| Bend | 2,000 | .... |
| Corvallis | 6,000 | 5,000 |
| **Virginia:** | | |
| Fredericksburg | 511 | .... |
| **Washington:** | | |
| Aberdeen | .... | 3,500 |
| **CANADA** | | |
| **Nova Scotia:** | | |
| New Glasgow | .... | 21,000 |

## Wrought Iron Pipe Laid in 1927

| City and tSate | Size, inches | Length laid, feet |
|---|---|---|
| **Arkansas:** | | |
| Fort Smith | 2 or less | 5,022 |
| **California:** | | |
| Fresno | 2 to 12 | 16,220 |
| **Connecticut:** | | |
| Hartford | .... | 758 |
| Norwich | .... | 1,059 |
| **Florida:** | | |
| Lakeland | .... | 60,000 |
| **Georgia:** | | |
| Albany | ¾ to 3 | 32,400 |
| Atlanta | ¾ to 2 | 29,744 |
| **Illinois:** | | |
| Pekin | .... | 2,468 |
| Quincy | 2 to 2½ | 487 |
| **Indiana:** | | |
| Richmond | 2 | 339 |
| **Maine:** | | |
| Calais | .... | 2,900 |
| **Massachusetts:** | | |
| Beverly | 1 to 2 | 445 |
| Danvers | 1 to 2 | 4,993 |
| Fairhaven | ¾ to 2 | 558 |
| Saugus | 1 to 1½ | 13,485 |
| South Hadley Falls | 2½ | 700 |
| Springfield | ¾ to 2 | 6,884 |
| **Michigan:** | | |
| Manistique | 1¼ | 350 |
| **Minnesota:** | | |
| Ely | .... | 5,810 |
| **Mississippi:** | | |
| Jackson | .... | 12,000 |
| Natchez | 2 | 1,000 |
| **Missouri:** | | |
| Joplin | .... | 8,600 |
| **New Hampshire:** | | |
| Claremont | .... | 7,169 |
| **North Carolina:** | | |
| Asheville | ½ to 3 | 36,267 |
| Greensboro | ¾ | 6,000 |
| **Ohio:** | | |
| Columbus | 2 | 19,100 |
| Lima | 1 | 669 |
| **Pennsylvania:** | | |
| Franklin | 16 | 200 |
| Huntingdon | 2 | 1,100 |
| **South Carolina:** | | |
| Charleston | 2 and less | 1,710 |
| **Tennessee:** | | |
| Jackson | 2 | 6,000 |
| **Vermont:** | | |
| Brattleboro | 2 | 400 |
| St. Johnsbury | ½ to 1 | 500 |
| **Virginia:** | | |
| Salem | 2 | 1,000 |
| **Washington:** | | |
| Aberdeen | 1½ to 2 | 8,000 |
| **Wisconsin:** | | |
| Ashland | 1 to 3 | 151 |
| Marinette | 2 | 200 |
| **CANADA:** | | |
| **Nova Scotia:** | | |
| New Glasgow | .... | 10,000 |
| **Ontario:** | | |
| Kitchener | 1 ¼ to 2 | 346 |

## Other Kinds of Pipe Laid in 1927

| City and State | Kind of Pipe | Size | Amount Laid |
|---|---|---|---|
| **Connecticut:** | | | |
| Naugatuck | Brass | 1" | 521 |
| Southington | W. I & steel | 2" | 1,090 |
| **Florida:** | | | |
| Palm Beach | Galvanized | 1"-3" | 3,000 |
| Augusta | Copper | .. | 2,000 |
| **Indiana:** | | | |
| Columbia City | Galvanized | 1"-2" | 3,697 |
| **Massachusetts:** | | | |
| Amesbury | Galv. w. i. | 2" | 1,500 |
| Danvers | W. i. cem't lined | 4"-6" | 1,000 |
| Haverhill | Lead | ½"-8" | 4,757 |
| **Minnesota:** | | | |
| Niles | Galvanized | 2" | 163 |
| Hibbing | Galvanized | 1½" | 237 |
| **Pennsylvania:** | | | |
| Franklin | Galvanized | 1½" & 2" | 3,300 |
| **Rhode Island:** | | | |
| East Providence | Cement lined | 2" | 2,324 |
| **Washington:** | | | |
| Aberdeen | Wood | 6" | 3,000 |
| **West Virginia:** | | | |
| Follansbee | Brass | 1¼" | 500 |
| **Wisconsin:** | | | |
| Ashland | Lead | ⅝"-¾" | 283 |

## Hydrants, Valves and Meters Placed and Service Connections Made in 1927

| City and State | Hydrants Placed | Gate Valves Placed | Service Meters Placed | Service Connections Made |
|---|---|---|---|---|
| **Alabama:** | | | | |
| Bessemer | 24 | .. | 3,000 | .. |
| Gadsden | .. | 14 | .. | 298 |
| **Arkansas:** | | | | |
| Fort Smith | 4 | 11 | .. | 265 |
| Van Buren | .. | .. | .. | 29 |
| **California:** | | | | |
| Fresno | 3 | .. | 72 | 315 |
| Modesto | 10 | 31 | 20 | 98 |
| Monterey, Pacific Grove, etc | .. | .. | .. | 579 |
| Santa Barbara | 51 | .. | 584 | 302 |
| **Colorado:** | | | | |
| Greeley | 12 | 7 | 25 | 183 |
| Lamar | .. | .. | 16 | 780 |
| **Connecticut:** | | | | |
| Bridgeport | 55 | .. | 570 | 881 |
| Danielson | 2 | 17 | 3 | 23 |
| Hartford | 70 | 310 | 1,178 | 1,055 |
| Naugatuck | .. | .. | 1 | 30 |
| Norwich | 11 | 42 | 114 | 70 |
| Plainville | .. | .. | 85 | .. |
| Putnam | .. | .. | .. | 16 |
| Southington | 6 | .. | .. | 40 |
| Torrington | 9 | 5 | .. | 96 |
| Wallingford | 4 | 27 | 17 | 40 |
| Willimantic | 4 | 3 | 36 | 29 |
| **Florida:** | | | | |
| Lakeland | .. | .. | 350 | .. |
| Orlando | 61 | 50 | 675 | 677 |
| Palm Beach | 107 | .. | 462 | 462 |
| St. Augustine | .. | .. | .. | 364 |

# Hydrants, Valves and Meters Placed and Service Connections Made in 1927

| City and State | Hydrants Placed | Gate Valves Placed | Service Meters Placed | Service Connections Made |
|---|---|---|---|---|
| **Georgia:** | | | | |
| Albany | 26 | 38 | 231 | 231 |
| Atlanta | 178 | 322 | .. | 2,552 |
| Augusta | 10 | .. | 467 | 532 |
| Thomasville | 37 | 105 | 153 | 153 |
| **Idaho:** | | | | |
| Twin Falls | 2 | 6 | 21 | 21 |
| **Illinois:** | | | | |
| Brookfield | 24 | 30 | 439 | 220 |
| Casey | .. | .. | 28 | 28 |
| Edwardsville | 9 | 20 | 250 | 110 |
| Evanston | 57 | 30 | .. | 1,421 |
| Highland Park | .. | .. | .. | 200 |
| Johnston City | .. | .. | .. | 126 |
| Kewanee | 11 | 18 | 100 | 125 |
| Mt. Carmel | .. | .. | .. | 12 |
| Paris | .. | .. | .. | 30 |
| Pekin | 3 | 18 | 160 | 160 |
| Rock Island | 20 | 40 | .. | 200 |
| Staunton | .. | .. | .. | 928 |
| Sterling | 7 | 12 | 140 | 83 |
| Zion | 50 | 40 | 150 | 150 |
| **Indiana:** | | | | |
| Bluffton | 3 | .. | 1,240 | 46 |
| Boonville | 2 | 4 | 14 | .. |
| Brazil | .. | .. | 54 | 54 |
| Columbia City | 116 | 5 | 120 | .. |
| Elkhart | 17 | 100 | 400 | 375 |
| Fort Wayne | 57 | 150 | 842 | 2,162 |
| Indianapolis | 181 | .. | 7,210 | 2,521 |
| Lebanon | 8 | 8 | .. | 35 |
| Muncie | 8 | 20 | 910 | 542 |
| Mishawaka | 35 | 84 | 295 | 667 |
| New Albany | 5 | 20 | 280 | 250 |
| Richmond | 2 | 30 | 308 | 171 |
| Seymour | 1 | 1 | 65 | .. |
| West Lafayette | 4 | 20 | .. | .. |
| Whiting | .. | .. | .. | 34 |
| **Iowa:** | | | | |
| Atlantic | .. | .. | .. | 5 |
| Burlington | 25 | 72 | .. | 124 |
| Creston | 2 | 2 | 50 | 50 |
| Des Moines | 29 | 27 | 407 | 314 |
| Dubuque | 13 | 39 | 219 | 179 |
| Fairfield | 23 | 45 | 70 | 70 |
| Hawarden | 1 | 1 | 30 | 30 |
| Lake City | .. | .. | .. | 9 |
| Marshalltown | .. | .. | .. | 90 |
| Mason City | 6 | 8 | 4,360 | 180 |
| Red Oak | 31 | 40 | 30 | 30 |
| Sioux City | 74 | 217 | 226 | 312a |
| **Kansas:** | | | | |
| Dodge City | 80 | 130 | 500 | 120 |
| Horton | 2 | .. | .. | 25 |
| Lawrence | .. | .. | .. | 200 |
| **Kentucky:** | | | | |
| Louisville | .. | 453 | 3,368 | 2,484 |
| Middleboro | .. | .. | 80 | 60 |
| **Louisiana:** | | | | |
| Crowley | .. | .. | 52 | 52 |
| Gretna | .. | .. | .. | 200 |
| **Maine:** | | | | |
| Calais | 1 | 2 | 38 | 25 |
| Caribou | .. | .. | .. | 8 |
| Houlton | .. | .. | .. | 14 |
| Sanford | .. | .. | .. | 56 |
| Skowhegan | .. | .. | .. | 11 |
| **Maryland:** | | | | |
| Frederick | 6 | 10 | 28 | 100 |
| Hagerstown | 11 | 21 | 56 | 78 |
| Salisbury | 111 | .. | 25 | 300 |
| **Massachusetts:** | | | | |
| Amesbury | 8 | .. | 375 | 53 |
| Athol | 5 | 15 | 191 | .. |
| Beverly | 14 | 46 | 221 | 116 |
| Brockton | 17 | 67 | 151 | 222 |
| Cambridge | 11 | 35 | .. | .. |
| Clinton | .. | .. | .. | 27 |
| Danvers | 13 | 42 | 207 | 93 |
| Fairhaven | 6 | 14 | 31 | 31 |
| Fitchburg | 16 | .. | .. | 74 |
| Framingham | 25 | 43 | 214 | 100 |
| Greenfield | 26 | 47 | 26 | 54 |
| Haverhill | 9 | 38 | 373 | 104 |
| Holyoke | 2 | .. | .. | 111 |
| Maynard | 2 | .. | .. | 20 |
| Melrose | 10 | .. | 193 | 240 |
| Milton | 26 | 66 | 185 | 195 |
| New Bedford | 19 | 33 | 92 | .. |
| Newburyport | .. | .. | .. | 57 |
| Northampton | 30 | 35 | 81 | 76 |
| North Adams | .. | 3 | .. | 20 |
| North Andover | 3 | 20 | 22 | 27 |
| Peabody | 3 | 23 | 146 | 118 |
| Saugus | 14 | .. | 280 | 193 |
| So. Hadley Falls | 7 | 8 | 15 | 10 |
| Spencer | 10 | 23 | 4 | 3 |
| Springfield | 95 | 216 | 752 | 733 |
| Ware | 11 | 14 | 100 | 4 |
| Webster | 5 | 16 | 127 | .. |
| Whitinsville | .. | .. | 1 | 3 |
| Winthrop | 4 | .. | .. | 103 |
| Worcester | 74 | .. | .. | 720 |
| **Michigan:** | | | | |
| Bessemer | .. | .. | 8 | 3 |
| Charlotte | 8 | 14 | 1,582 | 17 |
| Coldwater | 1 | 10 | .. | 30 |
| Detroit | 1,936 | .. | 16,950 | 16,950 |
| Escanaba | 1 | .. | .. | 60 |
| Gladstone | 4 | 4 | .. | 18 |
| Hastings | 1 | 1 | 30 | 8 |
| Holland | 18 | 35 | 113 | 111 |
| Iron Mountain | 10 | .. | 200 | .. |
| Jackson | 35 | 69 | 373 | 376 |
| Lapeer | .. | .. | 3 | 15 |
| Ludington | .. | .. | .. | 50 |
| Menominee | .. | .. | .. | 30 |
| Monroe | 20 | .. | 100 | 100 |
| Niles | 39 | 100 | 100 | 104 |
| Saginaw | 18 | 99 | .. | 1,337 |
| St. Johns | .. | .. | .. | 8 |
| St. Joseph | 30 | 50 | 75 | 75 |
| Sault Ste. Marie | 3 | .. | .. | 10 |
| Traverse City | .. | .. | .. | 52 |
| **Minnesota:** | | | | |
| Bemidji | .. | .. | .. | 12 |
| Cloquet | 4 | 4 | 16 | 16 |
| Duluth | 5 | 79 | .. | 427 |
| Ely | 9 | 17 | 59 | 65 |
| Hibbing | 4 | .. | 74 | 92 |
| International Falls | 4 | .. | 840 | 30 |
| Minneapolis | .. | .. | .. | 2,500 |
| Moorhead | 12 | 35 | 90 | 85 |
| South St. Paul | .. | .. | .. | 118 |
| St. Cloud | 13 | 18 | .. | 194 |
| Staples | .. | .. | .. | 20 |
| Stillwater | .. | .. | 400 | 56 |
| **Mississippi:** | | | | |
| Jackson | 160 | 144 | 600 | 246 |
| Natchez | 4 | 20 | 455 | 150 |
| **Missouri:** | | | | |
| Joplin | 9 | 13 | 564 | 356 |
| Paris | .. | .. | 10 | .. |
| Sedalia | 6 | 20 | 150 | 150 |
| Trenton | .. | 1 | 40 | 40 |
| Washington | .. | .. | 60 | 60 |
| **Montana:** | | | | |
| Billings | .. | .. | 40 | 32 |
| Havre | .. | .. | 74 | 74 |
| Kalispell | 16 | 14 | 35 | 19 |
| Lewistown | .. | .. | .. | 6 |
| Libby | .. | .. | .. | 15 |
| Missoula | 3 | 2 | .. | 69 |
| **Nebraska:** | | | | |
| Fairbury | 2 | 6 | .. | .. |
| Fremont | 4 | 8 | .. | 75 |
| Grand Island | 5 | 5 | 125 | 125 |
| Lincoln | 95 | 164 | 446 | 414 |
| Nebraska City | 4 | 4 | .. | 45 |
| Schuyler | .. | .. | 17 | 17 |
| Scotts Bluff | 16 | 34 | .. | 150 |
| Sidney | .. | .. | .. | 34 |
| York | .. | .. | .. | 24 |
| **New Hampshire:** | | | | |
| Claremont | 3 | 11 | 49 | .. |
| Lebanon | 2 | .. | .. | 22 |
| Manchester | 24 | 51 | 850 | 224 |
| Rochester | 2 | 1 | 34 | 26 |
| **New Jersey:** | | | | |
| Belleville | 16 | 27 | .. | 331 |
| Clifton | 4 | .. | 119 | 128 |
| Glen Ridge | 15 | .. | 96 | 106 |
| Irvington | 2 | 60 | 752 | 672 |
| Newark | 188 | 242 | 1,306 | 1,603 |
| Plainfield | 82 | .. | 1,806 | 2,438 |
| Red Bank | 3 | 6 | 66 | 66 |
| **New York:** | | | | |
| Binghamton | 14 | 36 | 215 | 329 |
| East Aurora | 1 | .. | 13 | 13 |
| Geneva | .. | .. | 55 | 55 |
| Gloversville | 11 | 16 | .. | 90 |
| Herkimer | 3 | .. | 20 | 20 |
| Hudson | 10 | .. | .. | 100 |
| Ithaca | 10 | .. | 150 | 150 |
| Johnson City | 11 | 24 | 97 | 99 |
| Little Falls | .. | 10 | 25 | .. |
| Mechanicsville | .. | .. | .. | 30 |
| Mount Vernon | 29 | 238 | 294 | 294 |
| North Tarrytown | 4 | 7 | 35 | 35 |
| Norwich | .. | .. | .. | 25 |
| Ossining | 8 | 16 | .. | 132 |
| Peekskill | 10 | 20 | 132 | 132 |
| Port Jervis | 1 | 12 | 54 | .. |
| Salamanca | 7 | 15 | 104 | 104 |
| Tarrytown | 15 | 29 | 50 | 50 |

| City and State | Hydrants Placed | Gate Valves Placed | Service Meters Placed | Service Connections Made |
|---|---|---|---|---|
| **North Carolina:** | | | | |
| Asheville | 84 | 360 | 1,000 | 1,000 |
| Charlotte | .. | .. | .. | 1,100 |
| Greensboro | 60 | 65 | 250 | 250 |
| Henderson | .. | .. | 60 | 60 |
| High Point | .. | .. | 300 | 300 |
| Rocky Mount | 16 | 24 | 216 | 314 |
| Thomasville | .. | .. | .. | 400 |
| **North Dakota:** | | | | |
| Enderlin | .. | .. | 12 | 12 |
| Fargo | 15 | 23 | 254 | 254 |
| Valley City | .. | .. | .. | 20 |
| **Ohio:** | | | | |
| Akron | 275 | 580 | 3,088 | 2,300 |
| Cincinnati | 106 | .. | 4,167 | 4,645 |
| Cleveland | 417 | 695 | 2,206 | 22,264 |
| Columbus | 96 | 46 | 2,146 | 3,330 |
| Conneaut | 3 | 26 | 2,782 | 118 |
| Crooksville | 67 | 62 | .. | .. |
| Defiance | 2 | 4 | .. | 132 |
| Delaware | 2 | 6 | 100 | 56 |
| Elyria | .. | .. | .. | 201 |
| Franklin | .. | .. | .. | 40 |
| Lima | 2 | 19 | 151 | 119 |
| Logan | 3 | 5 | 8 | 20 |
| Marietta | .. | .. | 100 | 85 |
| Nelsonville | .. | .. | .. | 10 |
| Norwalk | .. | .. | 68 | 68 |
| Piqua | 2 | 12 | 172 | 165 |
| Salem | .. | 12 | .. | .. |
| Sidney | 4 | 7 | 33 | 33 |
| Shelby | .. | .. | .. | 60 |
| Sylvania | 6 | 4 | 30 | 24 |
| Warren | 31 | 71 | 294 | 294 |
| Youngstown | 80 | 246 | 1,606 | 1,647 |
| **Oklahoma:** | | | | |
| Blackwell | 36 | 15 | 100 | 100 |
| Madill | .. | .. | 12 | 12 |
| Norman | 2 | 4 | .. | 25 |
| Vanita | 135 | 23 | 1,015 | 67 |
| **Oregon:** | | | | |
| Bend | .. | .. | .. | 60 |
| Corvallis | 4 | 20 | 60 | 60 |
| **Pennsylvania:** | | | | |
| Aliquippa | 39 | .. | 416 | 540 |
| Bedford | .. | .. | 7 | 7 |
| Bethlehem | 33 | 153 | 600 | 687 |
| Clearfield | .. | 4 | 71 | 30 |
| Ford City | 2 | 2 | .. | 3 |
| Franklin | 6 | 6 | .. | .. |
| Freeland | 4 | .. | 1,800 | 26 |
| Hamburg | 2 | 4 | 25 | 25 |
| Huntingdon | 3 | 10 | 5 | 22 |
| Kittanning | 3 | 3 | .. | 55 |
| Lehighton | 4 | 20 | .. | 35 |
| Midland | .. | .. | 18 | 48 |
| Mount Union | .. | 7 | 4 | 20 |
| Philipsburg | .. | .. | .. | 4 |
| Reading | 13 | 39 | 217 | 232 |
| Sayre | .. | .. | .. | 40 |
| Sewickley | .. | 1 | .. | 39 |
| Shamokin | 15 | .. | 2,300 | 250 |
| Shenandoah | 2 | 12 | .. | .. |
| Springdale | 1 | 3 | .. | .. |
| Steelton | .. | .. | .. | 87 |
| **Rhode Island:** | | | | |
| East Providence | .. | .. | 220 | 199 |
| South Kingstown | 6 | 8 | 50 | 104 |
| Westerly | 4 | 18 | 106 | 102 |
| Woonsocket | 48 | 134 | 200 | 200 |
| **South Carolina:** | | | | |
| Chester | .. | .. | 47 | 41 |
| Charleston | 30 | 52 | 187 | 187 |
| Columbia | 46 | 50 | 465 | 465 |
| Spartanburg | .. | .. | .. | 400 |
| **Tennessee:** | | | | |
| Dyersburg | 10 | 12 | 100 | .. |
| Jackson | 24 | 46 | 32 | 163 |
| Knoxville | 247 | 1,644 | 1,000 | 1,000 |
| **Texas:** | | | | |
| Childress | 42 | 40 | 200 | 200 |
| San Antonio | 45 | .. | 6,128 | .. |
| Wichita Falls | 10 | 32 | 900 | 900 |
| **Utah:** | | | | |
| Beaver | .. | 1 | .. | 10 |
| **Vermont:** | | | | |
| Bellows Falls | 2 | 8 | 834 | 5 |
| Brattleboro | | | | |
| St. Johnsbury | | | | |
| **Virginia:** | | | | |
| Fredericksburg | 9 | 50 | 6 | 169 |
| Harrisburg | 12 | 22 | 45 | 52 |
| Lexington | .. | .. | 400 | .. |
| Salem | 12 | 36 | 50 | 50 |
| Winchester | 6 | .. | 250 | 137 |
| **Washington:** | | | | |
| Aberdeen | 10 | 48 | .. | 302 |
| **West Virginia:** | | | | |
| Follansbee | .. | .. | 100 | .. |
| Princeton | .. | .. | 22 | 22 |

| City and State | Hydrants Placed | Gate Valves Placed | Service Meters Placed | Service Connections Made |
|---|---|---|---|---|
| **Wisconsin:** | | | | |
| Antigo | 8 | 24 | 150 | 50 |
| Ashland | .. | .. | 25 | 22 |
| Baraboo | 3 | .. | 1,480 | 33 |
| Clintonville | .. | .. | .. | 20 |
| Cudahy | .. | .. | 40 | 40 |
| Fond du Lac | 14 | 39 | 342 | 89 |
| Janesville | 27 | 33 | 180 | 175 |
| Kenosha | 72 | 146 | 467 | 467 |
| La Crosse | .. | .. | .. | 169 |
| Madison | 60 | 100 | 600 | 750 |
| Marinette | 0 | 3 | 12 | 12 |
| Manitowoc | 20 | .. | 277 | 277 |
| Menasha | 12 | .. | 82 | 112 |
| Milwaukee | 460 | 1,171 | 4,285 | 6,184 |
| Neenah | 6 | .. | 150 | 140 |
| Plymouth | 1 | 1 | 15 | 15 |
| South Milwaukee | 15 | 15 | 131 | 172 |
| Two Rivers | 19 | .. | .. | 177 |
| Wassau | .. | .. | .. | 189 |
| Watertown | 13 | 13 | 127 | 127 |
| Wauwatosa | 27 | 51 | 576 | 545 |
| Wisconsin Rapids | 6 | 8 | .. | 83 |
| Whitewater | 1 | 1 | .. | 64 |

## Services and Meters in Active Use

| City and State | Active Services | Meters in Use | Per Cent Metered |
|---|---|---|---|
| **Alabama:** | | | |
| Bessemer | 7,175 | 7,281 | 100 |
| **Arkansas:** | | | |
| Van Buren | 1,440 | 1,414 | 98 |
| **California:** | | | |
| Dinuba | 1,000 | 975 | 97 |
| Fresno | 17,713 | 2,270 | 13 |
| Modesto | 3,878 | 154 | 4 |
| Santa Barbara | 8,661 | 8,145 | 94 |
| **Colorado:** | | | |
| Greeley | 2,919 | 434 | 15 |
| Lamar | 730 | 730 | 100 |
| **Connecticut:** | | | |
| Bridgeport | 26,715 | 7,241 | 27 |
| Danielson | 832 | 59 | 7 |
| Hartford | 21,508 | 32,049 | 100 |
| Naugatuck | 2,155 | 77 | 4 |
| Norwich | 5,000 | 2,368 | 47 |
| Putnam | 1,280 | 68 | 5 |
| Southington | 1,700 | 281 | 16 |
| Torrington | 3,700 | 285 | 8 |
| Wallingford | 2,138 | 551 | 26 |
| Willimantic | 1,824 | 1,732 | 95 |
| **Florida:** | | | |
| Orlando | 7,486 | 8,000 | 100 |
| Palm Beach | 6,527 | 6,539 | 100 |
| St. Augustine | 2,200 | 2,350 | 100 |
| **Georgia:** | | | |
| Albany | 2,430 | 2,430 | 100 |
| Augusta | 10,500 | 10,500 | 100 |
| Thomasville | 1,445 | 1,445 | 100 |
| **Idaho:** | | | |
| Twin Falls | 2,250 | 2,250 | 100 |
| **Illinois:** | | | |
| Brookfield | 2,030 | 2,030 | 100 |
| Edwardsville | 1,772 | 1,472 | 85 |
| Evanston | 9,600 | 9,600 | 100 |
| Farmington | 3 25 | 325 | 100 |
| Johnston City | 946 | 946 | 100 |
| Highland Park | 4,000 | 4,000 | 100 |
| Kewanee | 2,669 | 2,660 | 100 |
| Mt. Carmel | 1,795 | 10 | 1 |
| Pekin | 3,519 | 3,502 | 100 |
| Quincy | 9,025 | 7,408 | 82 |
| Rock Island | 8,500 | 6,442 | 76 |
| Sterling | 3,128 | 2,601 | 83 |
| Zion | 200 | 200 | 100 |
| **Indiana:** | | | |
| Bluffton | 1,280 | 1,240 | 97 |
| Boonville | 1,150 | 149 | 13 |
| Brazil | 1,334 | 1,334 | 100 |
| Elkhart | 7,600 | 7,550 | 99 |
| Fort Wayne | 26,000 | 26,000 | 100 |
| Indianapolis | 70,840 | 32,350 | 46 |
| Lebanon | 1,870 | 1,900 | 100 |
| Mishawaka | 5,257 | 5,257 | 100 |
| Muncie | 8,200 | 7,000 | 85 |
| Richmond | 7,180 | 7,271 | 100 |
| Princeton | 2,108 | 1,350 | 64 |
| Seymour | 1,700 | 560 | 33 |
| **Iowa:** | | | |
| Burlington | 7,114 | 498 | 7 |
| Creston | 1,500 | 1,500 | 100 |
| Fairfield | 1,300 | 1,450 | 100 |
| Des Moines | 28,914 | 28,670 | 99 |
| Hawarden | 372 | 372 | 100 |
| Dubuque | 8,100 | 8,249 | 100 |
| Lake City | 335 | 350 | 100 |
| Red Oak | 1,743 | 1,743 | 100 |
| Mason City | 4,360 | 4,360 | 100 |
| Sioux City | 18,459 | 16,200 | 88 |
| **Kentucky:** | | | |
| Louisville | 59,694 | 13,671 | 23 |
| Middleboro | 2,034 | 854 | 42 |
| **Kansas:** | | | |
| Dodge City | 2,800 | 2,800 | 100 |
| Horton | 710 | 710 | 100 |

## Services and Meters in Active Use

| City and State | Plant or Private Municipal | Under 6-inch | 6, 8, 10 and 12-in. | Over 12-inch |
|---|---|---|---|---|
| **Louisiana:** | | | | |
| Crowley | | 969 | 960 | 100 |
| Gretna | | 1,001 | 1,000 | 100 |
| **Maine:** | | .... | | |
| Calais | | 1,767 | 409 | 24 |
| Houlton | | 1,233 | 10 | 1 |
| Sanford | | 2,010 | 1,700 | 85 |
| **Maryland:** | | | | |
| Frederick | | 33,000 | 125 | 1 |
| Salisbury | | 1,300 | 50 | 4 |
| **Massachusetts:** | | | | |
| Beverly | | 5,249 | 4,446 | 85 |
| Brockton | | 11,459 | 11,189 | 98 |
| L..q..876 | ..b6 .. | | | |
| Danvers | | 2,600 | 865 | 33 |
| Fairhaven | | 2,345 | 2,345 | 100 |
| Framingham | | 3,929 | 4,126 | 100 |
| Greenfield | | 3,278 | 673 | 20 |
| Haverhill | | 8,541 | 6,910 | 81 |
| Holyoke | | 5,922 | 484 | 8 |
| Lenox | | 324 | 410 | 100 |
| Melrose | | 5,298 | 5,335 | 100 |
| Milton | | 3,535 | 3,535 | 100 |
| Northampton | | 4,152 | 4,152 | 100 |
| North Adams | | 3,578 | 1,924 | 54 |
| North Andover | | 1,461 | 1,399 | 96 |
| Peabody | | 3,718 | 3,200 | 85 |
| Saugus | | 3,063 | 280 | 9 |
| So. Hadley Falls | | 816 | 104 | 13 |
| Springfield | | 21,824 | 21,624 | 96 |
| Stoneham | | 2,125 | 2,125 | 100 |
| Ware | | 994 | 1,025 | 100 |
| Whitinsville | | 660 | 34 | 5 |
| Worcester | | 27,806 | 27,145 | 98 |
| **Michigan:** | | | | |
| Bessemer | | 778 | 768 | 99 |
| Charlotte | | 1,680 | 1,582 | 94 |
| Detroit | | 234,640 | 232,674 | 99 |
| Hastings | | 1,610 | 1,383 | 84 |
| Holland | | 3,623 | 3,623 | 100 |
| Iron Mountain | | 2,500 | 2,500 | 100 |
| Jackson | | 11,462 | 11,462 | 100 |
| Lancer | | 1,050 | 25 | 3 |
| Ludington | | 2,100 | 2,000 | 95 |
| Monroe | | 3,800 | 3,800 | 100 |
| Niles | | 2,400 | 2,400 | 100 |
| St. Johns | | 1,320 | 400 | 3 |
| St. Joseph | | 1,850 | 1,850 | 100 |
| Sault Ste. Marie | | 3,300 | 500 | 15 |
| **Minnesota:** | | | | |
| Bemidji | | 750 | 750 | 100 |
| Cloquet | | 1,381 | 1,381 | 100 |
| Ely | | 1,092 | 1,027 | 94 |
| Hibbing | | 3,646 | 2,527 | 69 |
| International Falls | | 750 | 840 | 100 |
| So. St. Paul | | 1,731 | 1,700 | 98 |
| Moorhead | | 1,215 | 1,237 | 100 |
| Staples | | 343 | 342 | 100 |
| St. Cloud | | 3,000 | 2,986 | 99 |
| Stillwater | | 1,550 | .... | 50 |
| **Mississippi:** | | | | |
| Jackson | | 7,490 | 5,956 | 80 |
| Natchez | | 1,800 | 1,700 | 95 |
| **Missouri:** | | | | |
| Joplin | | 8,000 | 4,500 | 56 |
| Sedalia | | 3,920 | 3,200 | 82 |
| Washington | | 700 | 760 | 100 |
| **Montana:** | | | | |
| Billings | | 3,582 | 3,684 | 100 |
| Havre | | 1,128 | 955 | 85 |
| Kalispell | | 1,550 | 1,298 | 84 |
| Lewistown | | 1,800 | 63 | 3 |
| Missoula | | 3,850 | 248 | 7 |
| **Nebraska:** | | | | |
| Fairbury | | 1,393 | 1,393 | 100 |
| Fremont | | 2,600 | 2,500 | 96 |
| Grand Island | | 4,000 | 4,000 | 100 |
| Nebraska City | | 1,352 | 1,240 | 92 |
| Lincoln | | 18,002 | 17,238 | 96 |
| Scotts Bluff | | 1,400 | 1,400 | 100 |
| Schuyler | | 503 | 503 | 100 |
| York | | 1,375 | 1,400 | 100 |
| **New Hampshire:** | | | | |
| Lebanon | | 1,050 | 395 | 38 |
| Manchester | | 10,162 | 10,057 | 99 |
| Rochester | | 1,976 | 1,565 | 79 |
| **New Jersey:** | | | | |
| Clifton | | 915 | 915 | 100 |
| Glen Ridge | | 1,554 | 1,532 | 98 |
| Irvington | | 8,097 | 8,097 | 100 |
| Newark | | 57,477 | 55,070 | 96 |
| Plainfield | | 21,000 | 18,982 | 91 |
| Red Bank | | 3,100 | 3,100 | 100 |
| **New York:** | | | | |
| Binghamton | | 12,700 | 12,656 | 100 |
| East Aurora | | 1,800 | 1,361 | 76 |
| Geneva | | 3,690 | 3,690 | 100 |
| Gloversville | | 4,957 | 4,852 | 98 |
| Herkimer | | 2,195 | 2,195 | 100 |
| Hudson | | 2,300 | 200 | 9 |
| Ithaca | | 4,987 | 4,987 | 100 |
| **New York** (Continued) | | | | |
| Mechanicsville | | 1,300 | 1,300 | 100 |
| Mount Vernon | | 8,250 | 8,250 | 100 |
| No. Tarrytown | | 1,050 | 1,050 | 100 |
| Norwich | | 2,094 | 2,050 | 98 |
| Peekskill | | 3,000 | 3,000 | 100 |
| Port Jervis | | 2,400 | 2,104 | 4 |
| Salamanca | | 2,574 | 2,683 | 100 |
| Tarrytown | | 1,227 | 1,227 | 100 |
| **North Carolina:** | | | | |
| Charlotte | | 16,600 | 14,000 | 84 |
| Asheville | | 11,396 | 11,396 | 100 |
| Greensboro | | 8,750 | 8,750 | 100 |
| Henderson | | 1,200 | 1,200 | 100 |
| High Point | | 5,500 | 5,500 | 100 |
| Rocky Mount | | 3,436 | 3,436 | 100 |
| Thomasville | | 1,500 | 1,500 | 100 |
| **North Dakota:** | | | | |
| Enderlin | | 378 | 278 | 100 |
| Fargo | | 5,117 | 5,117 | 100 |
| Valley City | | 909 | 909 | 100 |
| **Ohio:** | | | | |
| Akron | | 42,863 | 44,278 | 100 |
| Cleveland | | 155,162 | 130,116 | 84 |
| Cincinnati | | 77,113 | 77,113 | 100 |
| Columbus | | 55,088 | 54,620 | 99 |
| Conneaut | | 2,792 | 2,782 | 100 |
| Cranville | | 475 | 375 | 79 |
| Franklin | | 1,000 | 175 | 17 |
| Lima | | 10,200 | 10,200 | 100 |
| Piqua | | 3,150 | 3,150 | 100 |
| Sidney | | 2,250 | 2,250 | 100 |
| Sylvania | | 410 | 400 | 97 |
| Warren | | 9,000 | 9,125 | 100 |
| Youngstown | | 31,472 | 31,472 | 100 |
| Blackwell | | 2,900 | 2,900 | 100 |
| Madill | | 400 | 400 | 100 |
| Norman | | 2,400 | 2,400 | 100 |
| Vinita | | 1,237 | 1,015 | 82 |
| **Oregon:** | | | | |
| Bend | | 2,320 | 225 | 10 |
| **Pennsylvania:** | | | | |
| Aliquippa | | 3,279 | 3,788 | 100 |
| Bedford | | 757 | 757 | 100 |
| Bethlehem | | 14,500 | 600 | 4 |
| Clearfield | | 2,503 | 2,305 | 92 |
| Ford City | | 1,560 | 1,560 | 100 |
| Freeland | | 1,376 | 1,800 | 100 |
| Hamburg | | 961 | 961 | 100 |
| Huntingdon | | 2,401 | 58 | 2 |
| Kattanning | | 2,000 | 55 | 3 |
| Lehighton | | 1,555 | 65 | 4 |
| Mount Union | | 1,275 | 105 | 8 |
| Reading | | 25,625 | 25,384 | 99 |
| Philipsburg | | 1,872 | 85 | 5 |
| Sewickley | | 1,460 | 1,400 | 96 |
| Shamokin | | 8,200 | 8,100 | 99 |
| Springdale | | 925 | 925 | 100 |
| Steelton | | 2,150 | 2,405 | 100 |
| West Newton | | 690 | 690 | 100 |
| **Rhode Island:** | | | | |
| East Providence | | 3,400 | 3,245 | 96 |
| Westerly | | 3,162 | 2,922 | 93 |
| South Kingstown | | 1,220 | 419 | 34 |
| Woonsocket | | 6,000 | 6,200 | 100 |
| **South Carolina:** | | | | |
| Chester | | 1,003 | 52 | 5.. |
| Charleston | | 9,928 | 11,341 | 100 |
| **Tennessee:** | | | | |
| Jackson | | 5,462 | 263 | 5 |
| Knoxville | | 22,000 | 22,000 | 100 |
| **Texas:** | | | | |
| Childress | | 1,600 | 1,800 | 100 |
| Wichita Falls | | 11,000 | 11,000 | 100 |
| **Vermont:** | | | | |
| Bellows Falls | | 836 | 834 | 100 |
| Brattleboro | | 1,600 | 128 | 8 |
| **Virginia:** | | | | |
| Harrisburg | | 2,000 | 1,200 | 60 |
| Lexington | | 985 | 530 | 54 |
| Salem | | 1,100 | 1,000 | 91 |
| Winchester | | 3,000 | 250 | 8 |
| **West Virginia:** | | | | |
| Princeton | | 1,326 | 1,449 | 100 |
| **Wisconsin:** | | | | |
| Antigo | | 1,500 | 700 | 47 |
| Ashland | | 2,150 | 1,073 | 50 |
| Baraboo | | 1,640 | 1,480 | 90 |
| Clintonville | | 484 | 556 | 100 |
| Cudahy | | 1,720 | 1,720 | 100 |
| Fond du Lac | | 6,367 | 6,482 | 100 |
| Janesville | | 4,500 | 4,531 | 100 |
| Kenosha | | 9,694 | 9,716 | 100 |
| La Crosse | | 8,319 | 7,732 | 93 |
| Madison | | 12,000 | 12,000 | 100 |
| Manitowoc | | 4,280 | 4,280 | 100 |
| Marinette | | 3,426 | 1,692 | 49 |
| Menasha | | 1,640 | 1,631 | 99 |
| Milwaukee | | 85,221 | 84,217 | 99 |
| Naanah | | 1,920 | 1,920 | 100 |
| Plymouth | | 975 | 970 | 99 |
| Two Rivers | | 1,680 | 1,780 | 100 |
| Watertown | | 2,428 | 2,428 | 100 |
| Wauwatosa | | 4,030 | 4,030 | 100 |
| Wisconsin Rapids | | 1,685 | 1,670 | 99 |

# Pumps and Pumping

| City & State | Kind of plumbing plant in regular Service | Kind of pumping plant in reserve | | | |
|---|---|---|---|---|---|
| **Alabama:** | | | | | |
| Bessemer | Electric | Electric | .... | .... | 1.6 |
| Gadsden | Seam & electric | Steam | .... | 7.5 | 1.25 |
| **Arkansas:** | | | | | |
| Fort Smith | Steam | Steam | .... | .... | 2.5 |
| Van Buren | Electric | Electric | .... | .... | .45 |
| **California:** | | | | | |
| Anaheim | Electric | .... | .... | .... | 1.5 |
| Dimba | Electric | Gasoline | .... | .... | .6 |
| Fresno | Electric | None | .... | 9.4 | 20.13 |
| Modesto | Electric | Electric | 60 | 11.1 | 4.0 |
| **Connecticut:** | | | | | |
| Bridgeport | None | Steam | .... | .... | .... |
| Groton | Electric | Electric | .... | .... | 1.25 |
| Plainville | None | Steam | .... | .... | .... |
| Putnam | Water | Electric | .... | .... | .19 |
| Wallingford | Electric | Electric | No pumping done | | |
| Willimantic | Steam & water | Steam & water | .... | .... | 1.2 |
| **Florida:** | | | | | |
| Lakeland | Steam & electric | .... | 75% | 36 | 1.5 |
| Orlando | Electric | Electric | .... | 30 | 2.5 |
| Palm Beach | Electric | Steam | 8%5 | .... | 4.7 |
| St. Augustine | Electric | Gasoline | .... | .... | 1.5 |
| **Georgia:** | | | | | |
| Atlanta | Steam | Steam | .... | .... | .... |
| Augusta | Hydraulic | Steam & elec. | .... | .... | 5.0 |
| Albany | Electric | Electric | .... | 13 | 1.5 |
| Thomasville | Steam & elec. | Steam & elec. | .... | .... | .... |
| **Idaho:** | | | | | |
| Twin Falls | Electric | Gasoline | Very little pumping | | |
| **Illinois:** | | | | | |
| Brookfield | Electric | Gasoline | .... | .... | .7 |
| Carbondale | Electric | Gasoline | 84% | 10 | 1.0 |
| Casey | Electric | Oil | .... | .... | 0.13 |
| Evanston | Steam | Electric | .... | 22.6 | 8.5 |
| Edwardsville | Electric | Steam | 70% | .... | 0.9 |
| Highland Pk | Steam, elec., & gasoline | .... | .... | .... | 0.02 |
| Farmington | Electric | Electric | .... | .... | 0.03 |
| Johnston City | Oil | Electric | .... | .... | 0.13 |
| Kewanee | Steam | None | .... | .... | 0.5 |
| Lockport | Electric | .... | .... | .... | 0.13 |
| Mt. Carmel | Electric | Steam | .... | .... | 1.0 |
| Paris | Electric | None | .... | .... | 1.2 |
| Pekin | Electric | Steam & gasoline | .... | .... | 1.0 |
| Quincy | Electric | Steam | 70% | .... | 2.44 |
| Rock Island | Steam & elec. | Steam & elec. | .... | .... | 3.5 |
| Staunton | Electric | None | .... | .... | 0.3 |
| Sterling | Steam | Steam | .... | .... | 1.2 |
| Zion | Electric | .... | .... | .... | .03 |
| **Indiana:** | | | | | |
| Batesville | Electric | Steam | .... | .... | 0.14 |
| Bluffton | Steam & elec. | | .... | .... | 0.25 |
| Boonville | Electric | Gasoline | .... | .... | 0.4 |
| Brazil | Steam | Steam | .... | .... | 0.4 |
| Columbai City | Steam & elec. | Steam | .... | .... | .... |
| Elkhart | Steam | Electric | .... | .... | 3.0 |
| Fort Wayne | Electric | .... | .... | $61.37a | 9.0 |
| Indianapolis | Steam, electric & hydraulic | Electric | .... | .... | 3.483.0 |
| Muncie | Steam | Steam | .... | .... | 3.5 |
| Lebanon | Steam | Electric | .... | .... | 0.37 |
| New Albany | Electric | .... | .... | .... | 1.9 |
| Mishawaka | Steam | Electric | .... | 64.5 | 1.6 |
| Princeton | Electric | Gasoline | .... | .... | 0.8 |
| Richmond | Steam | .... | .... | .... | 3.5 |
| Selmor | Steam & hydraulic | Steam | .... | .... | 1.5 |
| W. Lafayette | Steam | Steam | .... | .... | .... |
| Whiting | Electric | Steam | .... | .... | 2.7 |
| **Iowa:** | | | | | |
| Atlantic | Electric | Steam | .... | .... | 0.6 |
| Burlington | Steam | Steam | .... | .... | 2.38 |
| Creston | Steam | Steam | .... | .... | 1.2 |
| Fairfield | Electric | Electric | .... | 2 | 0.35 |
| Des Moines | Steam | Steam | 71.2%b | 23.4c | 12.78 |
| Hawarden | Electric | None | .... | .... | 0.1 |
| Dubuque | Electric | Steam | .... | .... | 3.0 |
| Lake City | Oil | Electric | .... | .... | 0.08 |
| Marshalltown | Steam | Steam | .... | .... | 2.5 |
| Mason City | Steam | Electric | .... | .... | 1.3 |
| Oskaloosa | Elec. & gasoline | Gasoline | 1.75 kw | .... | 0.7 |
| Red Oak | Electric | Electric | 80% | 10 | 0.5 |
| Sioux City | Electric, oil & steam | Steam | .... | .... | 5.47 |
| **Kansas:** | | | | | |
| Dodge City | Electric | Steam | .... | .... | 0.8 |
| Fort Scott | Steam | Electric | .... | .... | 1.6 |
| Horton | Oil & electric | Oil electric | 75% | 31 | 0.3 |
| Lawrence | Steam | Steam | .... | .... | 1.3 |
| **Kentucky:** | | | | | |
| Hickman | Electric | Elec. & steam | 65% | .... | 0.1 |
| Louisville | Steam | Steam | 86,125,089 lbs. per 100 | 4.19 lb. coal | 42.01 |
| Middleboro | Electric | .... | .... | .... | 0.8 |
| **Louisiana:** | | | | | |
| Crowley | Diesel electric | None | .... | .... | 0.45 |
| **Maine:** | | | | | |
| Calais | Electric | Steam | .... | .... | .... |
| Caribou | Electric | Electric | .... | .... | 0.4 |
| Houlton | Electric | Steam | .... | 7.48 | 1.0 |
| Sanford | Electric | Electric | | | |
| Skowhegan | Electric | Electric | .... | .... | 0.13 |
| **Maryland:** | | | | | |
| Hagerstown | Electric | .... | 74% | .... | 4.0 |
| Salisbury | Electric | Fuel oil | .... | 27.8d | 0.5 |
| **Massachusetts:** | | | | | |
| Amesbury | Electric | .... | .... | .... | 0.66 |
| Beverly | Electric | Steam | .... | 17 | 1.4 |
| Brockton | Steam | .... | .... | 7.3 | 3.85 |
| Cambridge | Steam | Steam | .... | .... | 11.97 |
| Danvers | Electric | Steam | .... | .... | 1.5 |
| Fairhaven | Steam | Electric | .... | .... | 0.44 |
| Framingham | Steam | Electric | .... | 15.8 | 1.4 |
| Greenfield | Electric | None | .... | .... | .... |
| Haverhill | Steam & elec. | Steam & elec. | 77% | 19.32 | 3.25 |
| Lenox | None (gravity) | Turbine elec. | .... | .... | None |
| Maynard | Steam | Steam | .... | .... | .... |
| New Bedford | Steam | Electric | 125,000000 | 9 | 9.0 |
| Neyburyport | Steam & elec. | Steam & elec. | .... | .... | 1.39 |
| North Adams | None | Steam | .... | .... | .... |
| No. Andover | Steam | Steam | 68,773,333 | 1.01 | 0.47 |
| Peabody | Steam & elec. | Steam | .... | .... | 3.07 |
| Saugus | Electric | .... | .... | .... | .... |
| Ware | Electric | Steam | 61.2% | 17.4e | 0.35 |
| Webster | Steam | Steam | .... | .... | 0.64 |
| Whitinsville | Electric | Electrci | .... | .... | 0.65 |
| **Michigan:** | | | | | |
| Bessemer | Electric | Steam | 82% | 16.5 | 0.16 |
| Charlotte | Steam | Steam | .... | .... | 0.005 |
| Coldwater | Steam & elec. | .... | .... | .... | .... |
| Detroit | Steam & elec. | Steam & elec. | .... | 4.62f | 211.9 |
| Escanaba | Steam & elec. | Steam | .... | .... | 1.0 |

| City & State | Kind of pumping plant in regular service | Kind of pumping plant in reserve | Plant efficiency last year | Average cost of pumping 1 mil. gal. 1 foot high | Average daily pumpage, million gallons |
|---|---|---|---|---|---|
| **Michigan** (Continued) | | | | | |
| Gladstone .... | Steam & elec. | .... | 87% | .... | 0.004 |
| Hastings ..... | Steam | Steam | .... | .... | 0.38 |
| Holland ..... | Electric | Steam | .... | .... | 1.32 |
| Iron Mountain. | Electric | Gas | .... | 8.7 | 1.0 |
| Jackson ..... | Steam | Steam | .... | 10.2 | 6.3 |
| Lapeer ..... | Steam | Steam | .... | .... | 0.9 |
| Ludington .... | Steam | Steam | .... | .... | 1.25 |
| Manistique ... | Electric | Gasoline | .... | .... | 0.63 |
| Menominee ... | Electric | Gasoline | .... | .... | 1.0 |
| Midland ..... | Electric | Electric | .... | .... | 0.3 |
| Monroe ..... | Steam | Electric | .... | .... | 2.09 |
| Niles ..... | Electric | Electric | .... | .... | 0.90 |
| Petosky ..... | Electric | Steam turbine | .... | .... | .... |
| Saginaw ..... | Steam & elec. | Electric | .... | .... | 18.0 |
| St. Johns ..... | Electric | Electric | .... | .... | 0.4 |
| St. Joseph .... | Steam | None | .... | .... | 15.0 |
| Sault Ste. Marie ..... | Electric | Steam | .... | .... | 4.0 |
| Traverse City. | Steam & elec. | Steam | .... | .... | 1.5 |
| **Minnesota:** | | | | | |
| Bemidji ..... | Electric | Electric | .... | .... | 0.33 |
| Cloquet ..... | Electric | Gasoline | .... | .... | 0.35 |
| Duluth ..... | Electric | Steam | .... | .... | 11.0 |
| Ely ..... | Electric | None | 75-80% | .... | .... |
| Hibbing ..... | Electric | Electric | .... | .... | 2.03 |
| Minneapolis .. | Electric | Steam | 83% | 3.2 | 47.0 |
| Moorhead .... | Electric | .... | .... | .... | 0.33 |
| St. Cloud ..... | Electric | Gasoline | .... | .... | 1.34 |
| So. St. Paul .. | Electric | .... | .... | .... | 0.45 |
| Staples ..... | Electric | Gas | .... | .... | .... |
| Stillwater .... | Electric | Steam | .... | .... | 1.0 |
| **Mississippi:** | | | | | |
| Jackson ..... | Steam & elec. | Electric | 82% | 24.5d | 5.25 |
| Natchez ..... | Electric | Steam | .... | .... | 1.1 |
| **Missouri:** | | | | | |
| Joplin ..... | Steam | Steam | .... | .... | 3.5 |
| Moberly ..... | Electric | Gasoline | .... | .... | 1.0 |
| Paris ..... | Electric | Electric | .... | .... | 0.10 |
| Sedalia ..... | Steam | Steam | .... | 10 | 2.19 |
| Trenton ..... | Electric | Electric | 70% | 7.36 | 1.0 |
| Washington .. | Steam & electric | Steam | .... | .... | 0.4 |
| **Montana:** | | | | | |
| Billings ..... | Electric | Electric | .... | 8 | 2.19 |
| Havre ..... | Electric | .... | .... | .... | 0.7 |
| Kalispell ..... | Electric | Steam | 72% | .... | 1.2 |
| **Nebraska:** | | | | | |
| Fairbury ..... | Electric | Steam | .... | .... | 0.8 |
| Fremont ..... | Steam & electric | Steam | 76% | .... | 2.0 |
| Grand Island.. | Steam & electric | Steam | .... | .... | 2.13 |
| Lincoln ..... | Steam, oil & elec. | Steam & electric | .... | .... | 7.55 |
| Nebraska City. | Electric | Electric | .... | .... | 1.5 |
| Schuyler ..... | Electric | Electric | 50% | .... | 0.18 |
| Scotts Bluff.... | Electric | Electric | .... | .... | 0.5 |
| Sidney ..... | Electric | Electric | .... | .... | .... |
| York ..... | Electric | Gasoline | .... | .... | 0.5 |
| **New Hampshire:** | | | | | |
| Lebanon ..... | Water power | Electric | .... | .... | 0.5 |
| Manchester ... | St'm, elec & water | Steam turbine | .... | 7.7 | 6.2 |
| **New Jersey:** | | | | | |
| Plainfield ..... | Steam | Steam | .... | 9.2 | 7.17 |
| Red Bank..... | Electric | Steam | .... | .... | 0.7 |
| **New York:** | | | | | |
| Binghamton... | Steam | Steam | .... | .... | 6.5 |
| East Amora... | Steam & electric | Steam | .... | .... | 0.45 |
| Geneva ..... | Steam | Steam | .... | .... | 1.96 |
| Herkimer ..... | Electric | Steam | .... | .... | 1.0 |
| Hudson ..... | None (gravity) | Steam | .... | .... | .... |
| Ithaca ..... | Hydraulic & elec. | Electric | .... | .... | 1.2 |
| Johnson City.. | Steam | Steam | .... | .... | .... |
| Mechanicsville. | Electric | Steam | .... | .... | 1.75 |
| Mount Vernon. | None (gravity) | Centrifugal | .... | .... | .... |
| No. Tarrytown. | Electric | None | .... | .... | 0.32 |

| City & State | Kind of pumping plant in regular service | Kind of pumping plant in reserve | Plant efficiency last year | Average cost of pumping 1 mil. gal. 1 foot high | Average daily pumpage, million gallons |
|---|---|---|---|---|---|
| **New York** (Continued) | | | | | |
| Norwich ..... | None (gravity) | Electric | .... | .... | .... |
| Ossining ..... | Electric | Steam | .... | .... | 0.71 |
| Peekskill ..... | Steam | .... | .... | .... | .... |
| Port Jervis.... | Electric | Steam | No pumping | .... | .... |
| Potsdam ..... | Steam & electric | .... | .... | .... | 0.7 |
| Salamanca .... | Electric | Gas | .... | .... | 1.2 |
| Tarrytown..... | Steam | Steam | .... | 14.5 | 1.1 |
| **North Carolina:** | | | | | |
| Asheville ..... | None | Electric & gas | .... | .... | .... |
| Charlotte ..... | Electric | Gasoline | .... | .... | 5.5 |
| Greensboro ... | Steam | Steam | .... | .... | 4.5 |
| Henderson .... | Steam, elec & gas. | Steam & gasoline | .... | .... | .... |
| High Point.... | Electric | Gasoline | 80% | .... | 3.0 |
| Rocky Mount.. | Steam & electric | Steam & electric | .... | 29 | 1.7 |
| Thomasville... | Elec. & gasoline | Electric | .... | .... | 0.5 |
| **North Dakota:** | | | | | |
| Enderlin ..... | Electric | Electric | .... | .... | .... |
| Fargo ..... | Electric | Steam | .... | .... | 2.3 |
| Valley City.... | Electric | Electric | 50% | .... | 0.06 |
| **Ohio:** | | | | | |
| Ada ..... | Electric | Oil | .... | .... | 0.08 |
| Akron ..... | Steam | Electric & steam turbine | .... | .... | 18.82 |
| Cincinnati .... | Steam | Steam | .... | .... | 50.0 |
| Cleveland ..... | Steam & electric booster | Gasoline | 74% | 3.84 | 160.0 |
| Columbus ..... | Steam & electric | None | .... | 5.6g | 28.0 |
| Conneaut ..... | Steam | Steam | .... | .... | 1.42 |
| Cranville ..... | Electric | Electric | .... | .... | 0.15 |
| Crooksville.... | Electric | Gasoline | .... | .... | .... |
| Defiance ..... | Electric | Gasoline | .... | .... | 0.67 |
| Delaware ..... | Steam | Steam | .... | .... | 0.88 |
| Elyria ..... | Steam | Steam | .... | 16.67 | 3.5 |
| Franklin ..... | Steam | Steam | .... | .... | 0.54 |
| Lima ..... | Steam | Steam | .... | .... | 4.70 |
| Logan ..... | Steam | .... | .... | .... | 0.8 |
| Norwalk ..... | Steam & electric | Steam & electric | .... | .... | 1.2 |
| Marietta ..... | Steam | Steam | .... | .... | 2.2 |
| Nelsonville.... | Steam | Steam | .... | .... | .... |
| Piqua ..... | Electric | Electric | .... | 7.5 | 1.75 |
| Salem ..... | Steam & electric | .... | .... | .... | 0.8 |
| Shelby ..... | Electric | .... | .... | .... | 0.8 |
| Sidney ..... | Electric | Steam | .... | .... | 0.7 |
| Sylvania ..... | Electric | Electric | .... | .... | 0.08 |
| Warren ..... | Electric | Electric | .... | .... | 3.0 |
| Youngstown... | Steam | Steam | .... | .... | .... |
| **Oklahoma:** | | | | | |
| Blackwell .... | Electric | None | .... | .... | 1.3 |
| Madill ..... | Oil | Oil | .... | .... | 0.17 |
| Norman ..... | Oil | Steam | .... | .... | 0.5 |
| Vinita ..... | Electric | Electric | .... | 19 | .... |
| **Pennsylvania:** | | | | | |
| Bedford ..... | None (gravity) | Steam & electric | .... | .... | .... |
| Bethlehem .... | Electric | Steam | .... | .... | 5.5 |
| Ford City..... | Electric | Electric | .... | 18.75 | 0.56 |
| Franklin ..... | Electric | Steam | .... | .... | 2.0 |
| Freeland ..... | Electric | Steam | 85% | 60 | 0.25 |
| Hamburg .... | None (gravity) | Electric air lift | .... | .... | .... |
| Huntingdon... | Electric | Electric | 78% | .... | 1.12 |
| Kittaning .... | Electric | Steam | .... | .... | 1.25 |
| Reading ..... | Steam & electric | Steam & kerosene | .... | 4.8 | 11.12 |
| Sayre ..... | Steam | Steam | 90% | .... | 1.0 |
| Sewickley .... | Gas | Steam | .... | .... | 0.9 |
| Shenandoah... | Electric | Electric | 62% | .... | 0.81 |
| Springdale .... | Electric | Electric | .... | 11.5h | 0.16 |
| Steelton ..... | Electric | Electric | .... | .... | 1.57 |
| West Newton. | Electric | Natural gas | .... | .... | 0.17 |
| **Rhode Island:** | | | | | |
| E. Providence. | Electric | Electric | 1.74 kw. per 1,000 gal. | .... | 1.1 |
| So. Kingstown. | Electric | Fuel oil | .... | .... | 0.38 |
| Westerly ..... | Steam & electric | Electric | .... | 13.6 | 1.21 |
| Woonsocket... | Steam & electric | .... | 80% | .... | 3.0 |

| | | | | | |
|---|---|---|---|---|---|
| **So. Carolina:** | | | | | |
| Chester | Electric | None | .... | .... | 0.6 |
| Columbia | Water power & electric | .... | .... | .... | 6.0 |
| Charleston | Steam | Steam | 80% | .... | 5.3 |
| Spartanburg | Electric | Electric | .... | .... | 2.6 |
| **Tennessee:** | | | | | |
| Dyersburg | Electric | Steam | .... | .... | 0.5 |
| Jackson | Steam | Steam | .... | .... | 3.2 |
| Knoxville | Elec. & turbine | Elec. & turbine | .... | .... | 9.1 |
| **Texas:** | | | | | |
| Childress | Electric & oil | Oil | .... | .... | 0.5 |
| San Antonio | Steam | Electric | .... | 23 | 25.0 |
| Wichita Falls | Electric | Electric | .... | .... | 4.5 |
| **Vermont:** | | | | | |
| St. Johnsbury | Water power | Steam | .... | .... | .... |
| **Virginia:** | | | | | |
| Fredericksburg | Electric | Electric | .... | 2h | 1.22 |
| Salem | Electric | Steam | .... | .... | 0.4 |
| Winchester | Electric | Steam | 68% | 2.25 | 2.0 |
| **Washington:** | | | | | |
| Aberdeen | None | Steam | .... | .... | .... |
| **W. Virginia:** | | | | | |
| Follansbee | Electric | .... | .... | .... | 0.3 |
| Princeton | Steam & electric | Steam & electric | .... | .... | 0.2 |
| **Wisconsin:** | | | | | |
| Antigo | Steam & electric | Steam & electric | .... | 4 | 0.9 |
| Ashland | Steam | Steam | .... | .... | 1.58 |
| Baraboo | Electric | Hydraulic | 85% | 26 | 0.4 |
| Clintonville | Electric | Steam | 50% | .... | 0.173 |
| Cudahy | Steam i | .... | .... | .... | .... |
| Fond du Lac | Steam & oil | Steam & oil | .... | .... | 2.0 |
| Janesville | Steam | Steam | .... | .... | .... |
| Kenosha | Steam | Steam | .... | 11.8 | 5.19 |
| La Crosse | Steam | None | .... | .... | .... |
| Madison | Steam | Electric | 54.7% | 12 | 6.0 |
| Manitowoc | Steam & electric | Either | 72% | .... | 1.88 |
| Marinette | Steam | Steam | .... | .... | 1.34 |
| Menasha | Oil-electric | Oil-electric | 79% | 15.7 | 1.3 |
| Milwaukee | Steam | Steam | .... | 6.46 & 4.62 | 76.7 |
| Neenah | Diesel | Diesel | .... | .... | 0.6 |
| Plymouth | Electric | Steam | .... | 22 | 0.23 |
| So. Milwaukee | Steam | Steam | .... | .... | 0.88 |
| Two Rivers | Electric | Steam | .... | .... | 0.3 |
| Watertown | Electric | Steam & gasoline | .... | .... | 0.85 |
| Wausau | Steam & electric | Steam | .... | 9.25 | 2.1 |
| Wisc. Rapids | Electric | Steam | 74 | .... | 0.5 |
| Wauwatosa | Electric | .... | .... | .... | 1.09 |
| Whitewater | Electric | Steam | .... | .... | .... |
| **CANADA:** | | | | | |
| **New Brunswick:** | | | | | |
| Moncton | Gas & electric | Electric | .... | .... | .... |
| St. Stephen | Electric | Gas | .... | .... | 0.7 |
| **Ontario:** | | | | | |
| Belleville | Electric & gasoline | Gasoline | .... | .... | 2.5 |
| Carleton Place | Electric & gasoline | Gasoline | .... | .... | 0.75 |
| Elmira | Electric | Electric & oil | .... | 9 | 0.09 |
| Huntsville | Electric | Electric & steam | .... | .... | 0.15 |
| Kitchener | Electric | Gasoline | .... | 14.2 | 1.95 |
| Lindsay | Steam, elec & gas. | Gasoline | .... | .... | 0.82 |
| Meaford | Electric | Gasoline & steam | .... | .... | 0.2 |
| Peterborough | Hydraulic | Steam | .... | .... | 2.22 |
| Prescott | Electric | Steam & gasoline | .... | .... | 0.5 |
| St. Catherines | Electric | Gasoline | .... | .... | 4.55 |
| St. Marys | Electric | Gasoline | .... | 27h | 0.25 |
| Tillsonburg | Electric | Electric | .... | .... | 0.20 |
| **Quebec:** | | | | | |
| Cap de la Madeline | Electric | Electric | .... | .... | 0.7 |
| Joliette | Hydraulic | Electric & steam | .... | .... | 2.3 |
| Levis | Electric | None | 70% | .... | 1.2 |
| St. Lambert | Electric | Gasoline | .... | .... | 1.1 |

a—Total lift; b—boiler efficiency; c—operating cost exclusive of fixed charges and depreciation; d—pumping plant only; e—pumping station expenses; f—electric power; g—high service, low service and booster; h—for power only; i—owned by Cudahy Bros.

# Dissertation on Asheville's Water Supply

By Stanley H. Wright*

PROLOGUE

A group of skilled surgeons stood about the operating table closely examining the patient under ether. Each selected that part of the body he believed afflicted and quietly removed it without serious regard to the work of his associate. There was no discussion as to the relative function of the organs removed. Needless to say the patient had no voice in the matter. Whether he recovered or not was to be a matter of vitality and endurance—or more surgeons.

Of course doctors do not operate in this fashion—they know better; and it is possible that engineers might take a leaf from their book. Not that all engineers are subject to the criticism implied, but it remains something of a question as to the niceness of the relative cooperation of engineers in reaching an engineering solution as compared with that of other professions, particularly as applied to surgery, medicine, and the law.

---

Asheville, N. C. is a fast growing mountain city, rapidly developing industrially, while so fortunately situated that its industries in no way interfere with the larger business of providing pleasure for tourists and of producing health for the ill.

The city has nearly $6,000,000 invested in its gravity water supply. It is in the very unusual situation of supplying water to its own municipality, of supplying a territory of greater size outside of the city limits, and in addition selling water to outside water companies. Thus a situation is created offering difficulties in economical distribution system supply and in the equitable adjustment of rates. The city in this case represents a corporation constituting the largest business operating in this territory with the water department as one of the principal factors in that business. This particular department in the past has been unable to maintain itself through self-supporting rates. It has neither earned the interest on its bonded indebtedness, nor has it earned or made an accounting for an amortization fund or depreciation reserve account. Such procedures have been common in the past to many cities. It is to be hoped that the public in general and public officials in particular will soon see the error of past ways so that the water departments of all municipalities can be placed upon a fair and business-like financial basis, thus creating a goal for the water works superintendent or manager to strive for.

Not only has the maintenance and operation of the Water Department of this particular city been somewhat confused, not to say neglected, but the city fathers themselves have been somewhat distressed by a multiplicity of engineering opinions and advice regarding the sources of supply. Perhaps one should state that this is not a criticism of the work of very able engineers so much as a plea for round table discussion by engineers who may be severally engaged to report on a given project. Let there be a sort of standardization of engineering practices and methods whereby concise and coordinated opinions, disclosing a clarity of judgment, will convey to the client the information which he seeks and which will enhance the average layman's respect for the profession.

*Chief engineer, Department of Public Works.

### THE WATER SUPPLY

Asheville has one large storage reservoir having a capacity of some 700,000,000 gallons, constructed in a drainage area of eight square miles. This storage reservoir is connected by about nine miles of 24-inch and 16-inch pipe lines to two distributing reservoirs having a capacity of 11,000,000 and 5,000,000 gallons respectively, and a standpipe having a capacity of 300,000. Adjoining this water-shed is an intake dam in a drainage area of fifteen square miles and connected through seventeen miles of 16-inch pipe line into the distributing reservoirs previously mentioned. The second water-shed has a storage reservoir site having a potential capacity at least equal to the present storage reservoir. This reservoir site is at a lower elevation than the present intake and would have about twenty-four square miles of water-shed. These developments lie to the northeast of the city.

To the southwest of the city, distance of about twenty-six miles and within the Pisgah National Forest Reserve, there is situated on the head waters of a small river a tremendous natural storage basin having a possible economic capacity of about 12,000,000,000 gallons, which can be created the construction of a dam not exceeding 150 feet in height. This area is forested and protected, coming under the supervision of the United States Department of Agriculture through its forestry service. The water is clear and soft, as is the water in the water-shed now developed. The quality of these waters is such that they leave nothing to be desired, remaining clear after the heaviest rainfall.

The citizens and city officials are confused as to the normal economical procedure for the development of the various water-sheds, as between those lying to the northeast and those lying to the southwest. So much so, that various civic bodies claim to excel in engineering knowledge whereby they are able to determine variously that one should be developed, that the other should be developed, that none should be developed, and possibly that that has been developed should have been some where or something else.

In these modern and organized times, protesting about something or other is a favorite indoor sport, provided that the target against which the shafts of protest are aimed is large anough to be in the public eye. We enjoy life in a city having a population variously estimated from 60,000 to 90,000. The water consumption and the territory served would more nearly indicate the latter figure. We are ambitious enough to believe that our water will soon love to touch the skins or at least 300,000 souls within ten years; or is it twenty ? or five ?

### DISTRIBUTION SYSTEM

For a city of its size, the distribution system is large. Our service pipes total in length some forty-five miles. There are 114 miles of 4-inch to 24-inch pipe within the city limits and 110 miles of 2-inch to 12-inch pipe outside the city limits. It is embarrassing to think of the percentage of unaccounted for water.

It should be understood that the figures refer only to those lines controlled and operated by the city water department. In addition there are eighteen water districts and water companies taking water from us through large meters and distributing it by independently operated systems. At present there are no equalizing reservoirs or standpipes at distant points on the system. The present distributing reservoirs are close together and situated near the sources of supply.

### OPERATING DIFFICULTIES

The political divisions, as represented by what might be called the "rough shod democrats" (those that like to kick) and the "myopic democrats" (a nod being as good as a wink to a blind "horse") —the readers may vary the party with their respective localities—are not the only factors in the operation and construction of a complicated water system. The city is parted, like a very knobby head, by the French Broad river, and is crossed by small pipe lines of limited capacity leading to a territory rapidly increasing in population and importance.

Elevations over the city vary from 1,900 to 2,400 feet with consequent extreme variation in operating pressures.

Uniformity of construction and standards cannot be obtained in the development of a municipal water system unless a clearer understanding is had of such matters by city officials, or unless municipal water departments, operated by thoroughly experienced men, are given unreserved powers and are not subjected to changes following the political change of administration. Asheville has five different types of fire hydrants, although 92% of the meters are of one type. The valves in the distribution mains are both right and left hand, the latter being about 10% of the whole, and nearly 100% of the outlying independent districts. One is inclined to scratch one's head before attempting to open or close a valve. This difficulty is further complicated by the lack of complete records.

The Engineering Department of the State Board of Health of North Carolina offers an example of helpful cooperation which might well be emulated by other states; and municipalities of other states might well demand and use similar service. The engineers of this board offer not only intelligent constructive criticism, but active coat-off, sleeves-up, sure-enough work in time of need and emergency. These facts are mentioned parenthetically and are offered as an anti-climax because the subject may or may not be relevant to this paper, depending on the point of view.

Let these ramblings be not misunderstood. A finer water supply than Asheville has the writer yet to see. It has a value far in excess of the dollars invested, particularly in the psychology of serving pure, untreated water to people who come here for health and pleasure. The sources have a potential capacity that are relatively unlimited. The gentle criticisms implied are offered in a way that has been hinted with the left hand and without tongue in cheek for the consideration of engineers and to remind the water superintendent, be he where he may, that it is for him to guard well his distribution system. He should tighten up his girth, so to speak, and demand of his administration board that he be given for his system such financial aid as is due and that it is his by right of his proven ability. The hands that pass through the collecting window will shake his own or wring his neck, depending on the service he can amiably render.

# PUBLIC WORKS

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries..... $4.00 year
Single copies, 35 cents each

Change of Address
Subscribers are requested to notify us promptly of change of address, giving both old and new addresses.

Telephone (New York): Longacre 8176
Western Office: Michigan-Ohio Building, Chicago

A. PRESCOTT FOLWELL, Editor
W. A. HARDENBERGH, Associate Editor


CONTENTS


THE MOKELUMNE WATER PROJECT. Illustrated ..... 209
To Survey Los Angeles Water Supply..... 211
Lining Westerly's Concrete Standpipe..... 212
Oxygen in River Water..... 212
Credit to Contractors..... 213
TIME SAVERS IN WATER ANALYSIS. Illustrated. By Maj. F. E. Daniels..... 213
A Chicago Sewer Job. Illustrated..... 215
Sewage Treatment in Connecticut..... 216
RIGID FRAME CONSTRUCTION FOR WESTCHESTER COMMISSION. Illustrated. By Arthur G. Hayden..... 217
Alberta Highway Work..... 221
Semi-Trailers on Road Construction..... 221
New York Highway Notes..... 221
BACKFILLING STREET CUTS IN ST. LOUIS... 222
Felt Base for Concrete Pavements ..... 222
Unit Prices, Oklahoma State Highway Work..... 223
SCHENECTADY SEWAGE PLANT OPERATION 223
Sewage Problems in California..... 225
REPORT ON NEW YORK SEWAGE DISPOSAL. 226
BULKING OF ACTIVATED SLUDGE..... 228
Garbage Disposal in Newton, Mass. Illustrated..... 228
STREET CLEANING IN TOLEDO ..... 229
WATER WORKS IN 1927 ..... 231
- Cast-Iron Pipe Laid in 1927..... 231
- Steel Pipe Laid in 1927..... 233
- Wrought-Iron Pipe Laid in 1927..... 233
- Other Kinds of Pipe Laid in 1927..... 233
- Hydrants, Valves and Meters Placed and Service Connections Made in 1927..... 233
- Services and Meters in Active Use..... 235
- Pumps and Pumping..... 237

DISSERTATION ON ASHEVILLE'S WATER SUPPLY. By Stanley H. Wright ..... 239
EDITORIAL NOTES..... 241
- Metering almost Universal—Plan Road Repairs for Traffic Convenience

WRITING TECHNICAL ARTICLES..... 242
SPECIAL ASSESMENT PROCEDURE..... 243
Permanence of Photographic Records..... 245
NOVEL SEWAGE TREATMENT METHODS IN SMALL PLANT. Illustrated..... 246
The Camera in Highway Construction..... 248
CONSTRUCTING TALLASSEE CONDUIT. Illustrated ..... 249
RECENT LEGAL DECISIONS..... 251


## Metering Almost Universal

Metering of water has become almost universal. The number of cities without meters becomes less every year. Reports from several hundred cities received by *Public Works* this year indicate that all but two or three per cent. of the cities of the entire country have at least begun metering.

To an engineer or water works superintendent there can seem to be no escaping the logic of metering. To a politician—but politics knows no logic. The water used and wasted must be paid for; the only questions are, shall it be paid for on the basis of service rendered (readiness to serve and consumption charge), or that of ability to pay (general taxes); and shall the careless be allowed to waste ten times as much water as the careful use, for which waste the careful pay.

With metering adopted, the logical aim would seem to be one hundred per cent. metering. This seems to be quite generally recognized. Of the cities reporting to us this year, 49½ per cent. are already one hundred per cent. metered and 38 per cent. last year metered more services than they installed, indicating a desire to get into the one hundred per cent. class.

Of the cities not entirely metered, 18 per cent. were ninety per cent. or more metered, and 11½ per cent. were fifty to ninety per cent. metered; leaving only 21 per cent. under 50 per cent. metered, and a number of these were making rapid strides toward complete metering.

Only about one per cent. of the cities reported no meters, while about one and a half per cent. gave no information on the subject, wherefore we assumed they were meterless and ashamed of it.

## Plan Road Repairs for Traffic Convenience

Of any hundred-mile section of state highway in any part of the country, a goodly portion is put under repair or reconstruction each year and the language-provoking detour takes its place temporarily. State highways are primarily through routes and travel over them is largely through travel; but with one or more strips always under construction, much of the value of the remainder of the through route is lost.

It seems as though it should be possible to devise a plan whereby this inconvenience to the traveling public could be lessened. In many cases there are two routes between two prominent cities, and it would seem to be common sense to repair only one of these at a time, leaving the other open for unrestricted and undetoured traffic. But in an eastern state with a high reputation for highway construction and maintenance, we have found year after year both alternative routes between a certain pair of objectives simultaneously obstructed by repairing of several short stretches.

If a construction program were adopted whereby, during one or two years, route No. 1 were put into condition to last for five years, route No. 2 being meantime kept open throughout; and No. 2 then be repaired and reconstructed while No. 1 is in continuous service, the through travel would be greatly convenienced. It is possible that during the former period repair costs on route No. 2 would be high, but we doubt if they would equal the costs to traffic

due to delays and wear and tear on automobiles now occasioned by detours they are compelled to take. And after all, the money comes from practically the same pockets, whether for road maintenance or for automobile repairs.

# Writing Techninal Articles*

An engineer or other technical man explains his ideas to others by the medium of words and drawings. All realize that there is no excuse for an inaccurate or slovenly drawing or one that can not be understood readily. And yet some engineers do not appreciate that the same criterion applies equally to the language of his explanation. A slovenly, muddled report or article will probably be taken (and justly so) as the work of a slovenly workman and a muddle-headed thinker.

It is seldom that all the details of a structure or project can be sufficiently explained by drawings alone; specifications and written descriptions are usually necessary to supplement the drawings.

Written descriptions serve also another purpose. The development of the plans for doing a good job is often facilitated by writing a complete description of them, logically arranged, even if no one but the engineer himself ever sees the description. When it comes to receiving recognition for good work, and especially to advancement in the profession, ability to write a clear, logical, comprehensive description of an engineering project is of the greatest value.

There should be no effort to create literature. Play on words, stirring of emotions, charm in the turning of a phrase, have no place in technical writing. What is wanted in such writing is ability to so describe a structure or technical idea that the reader can, without too much mental effort, understand exactly what you want him to.

Only second in importance is the employment of words and language such as are held by educated men to conform to good usage. Also they should be so selected as to leave no possibility of doubt as to the meaning intended. Loose use of adjectives, such as "fine" (meaning excellent) may be deceptive. "The contractor used fine sand for the job" may really mean that he used coarse sand. Another illustration of careless use of words which is often seen (although really incorrect and meaningless) is the statement that this or that lies "between" a single object; as "twenty posts are to be placed in a line with 50 feet between each post." If such a specification clause were taken into court, the judge might decide that the intent was apparent but he would be justified in criticizing the engineer who wrote it; and the engineer should appreciate that he had done his little part towards lowering the opinion of engineers which is entertained by the intelligent public and which many of us are striving to elevate. One may perhaps be excused for using words in general talk with a popular though inexact meaning, but an engineer knows the need of precision in the use of instruments and of figures, and in important statements precision in the use of words is equally vital.

There are three essentials to the writing of a good technical article; that you have something worth while to say; that you take pains so to say it as to convey to the reader just what you have in mind; and that you stop when it has been said.

In selecting what to write about, put yourself in the place of the readers for whom you are writing and try to determine what points of the matter in hand they would find instructive or of interest. In a comprehensive description, features common in engineering practice and therefore of no special interest may have to be referred to, but treat them as briefly as possible, making of them a background against which the features of special interest may be brought out in relief by the specially detailed description given of them. A short article of one hundred or two hundred words describing some small detail of an engineer's plan or of a contractor's methods of construction may be more worth while than many a 2,000-word article.

But whatever you write about, be sure you know all the facts; and if, while writing, you discover (as you often will) that you have overlooked ascertaining one or more important points, do not guess at them, or leave your article incomplete by omitting them, but obtain the necessary information. Thus you will learn observation and obtain drill in thoroughness of understanding.

Try to be sure that you so express your ideas that the reader will know just what they are. The less mental effort required of him to determine your meaning, the greater the certainty that he will not misunderstand you and the higher will be his regard of your abilty. Crossword puzzles are good mental exercise but they have no place in a technical article.

Arrange the facts in a logical order; otherwise the reader will be confused and may fail altogether to grasp your meaning. It is advisable to prepare a general outline of the proposed manner of treatment before beginning the writing of the article; or in some cases to introduce your article with a general outline of the work, following with a series of descriptions of the separate features, preferably in the order in which they are referred to in the outline.

Having outlined your article, write it through in your natural manner of thinking and speaking—never mind the style in the first writing, but get all the facts down and arranged in a logical order. That done, go over the article and try to state each fact in the most concise and clear manner possible.

Few beginners at writing appreciate the value of conciseness. Some feel that the longer the article the more creditable it is to them; whereas the reverse is true—the shorter an article (provided clearness is not sacrificed for brevity) the greater the credit. The man who said in a postscript to his letter: "Excuse this long letter—I did not have time to write a short one," stated a truth very neatly. Except for some experienced writers, almost anyone can condense, recondense and again condense

*Abstract from a lecture by the editor of Public Works before the engineering students of the University of Florida.

almost anything he writes. The shorter the article the greater the probability that it will be read. I believe that the great majority of engineers, in looking over a technical paper or society proceedings, read the shorter articles; but the longer ones, unless of unusual personal interest to them, they lay one side to be read when they have more time—which time never comes.

Use short, simple words—preferably of Anglo-Saxon origin. Huxley said that if a man *really knows* his subject "he will be able to speak of it in an easy language and with the completeness of connection with which he talks of an every-day matter. If he does not, he will be afraid to wander beyond the limit of technical phraseology." A diplomat is said to have stated that language is a medium for concealing ideas. Be sure that in your writing it does not become a medium for concealing lack of ideas.

When called upon to describing engineering structures, work or projects to non-engineering readers, as by articles in the daily press, do not try to awe them or dodge the responsibility of explaining the matter by the use of super-technical terms. That is childish and will not attain the end which you should have in mind, that of enlightening or informing them. It is worse than unnecessary to refer to a scrap heap as a congeries of heterogenous articles.

And when you have finished, stop. Many an article has come to our hands which is continued beyond the logical stopping place for several paragraphs or even pages in which the author dribbles along shreds of ideas which have nothing to do with the article; or if they do, should have been included in some eaarlier paragraphs and were apparently just appended because the author was too lazy to go back and insert them where they logically belonged.

# Special Assessment Procedure*

**Cost vs. benefit assessments. Summary of assessment practice in twenty-four cities. Methods of paying contractors.**

Special assessments are an important source of funds for the construction of municipal improvements. Their amount in some cities exceeds the amount of taxes collected to pay bonds. There are limits on taxes and limits on indebtedness; but fewer limits on the amount of special assessments except for the theoretical one that they cannot exceed the benefits on any certain piece of property. Actually property is sometimes abandoned because of exorbitant special assessments.

In spite of the importance of this source of revenue, very little attention has been paid to the problem. There is little uniformity, and practically no standard of procedure. Many Kansas City property owners felt that they paid higher special assessments than do those in other cities. The present study was made to get the facts in the matter. Questionnaires were sent to all of the larger cities in the country and to a few smaller ones near Kansas City. Twenty-three replies were received. The facts contained in this report are based upon information from the following cities: Philadelphia, Detroit, Cleveland, St. Louis, Baltimore, Los Angeles, Pittsburgh, San Francisco, Buffalo, Milwaukee, Newark, Minneapolis, New Orleans, Kansas City, Seattle, Indianapolis, Rochester, Toledo, Portland, Denver, St. Paul, Omaha, Des Moines, and Duluth.

## THEORY AND PRACTICE OF SPECIAL ASSESSMENTS

1. *Types.* Special assessments are levied only when there is a special benefit to the property. This report deals with two types of special assessments.

(a) Assessments on properties within a district created for the purpose to pay part or all of the cost of specified improvements constructed or services rendered within that district. Street improvements are an example. The cost is assessed again the properties in various ways—front footage, area, or valuation.

(b) Assessments on properties benefited by public improvements or services in proportion to, and not in excess of, the amount of such benefit. Park purchases are an example in Kansas City. The benefits and assessments are generally determined by a commission or a jury.

2. *Cost* vs. *benefit.* Two distinct types of special assessments have come to be confused under the common term of benefit assessments. In the true benefit assessments, an honest attempt is made to measure the probable enhancement in land value which may reasonably be expected as a result of the improvement, and to apportion the costs on the properties affected in proportion to, but not in excess of, these anticipated enhancements. In the other type—which for brevity will hereafter be referred to as a cost assessment—the apportionment of cost is based directly on some physical characteristic of the property which affects cost; such as frontage, for example, in the case of street paving and sidewalks, and area in the case of storm sewers or combined storm and sanitary sewers. Under certain circumstances, the spreads made by the latter method for minor improvements will conform with reasonable accuracy to a true benefit assessment. In the case of all improvements, however, which benefit an extensive area, as well as in many purely local improvements in sections when the lot lay out is irregular, or the topography uneven, the spread of costs on the basis of physical functions of costs is not in harmony with benefits.

The legal limitations found in all cities may be fixed by the state constitution, by state law, or by city charter. They regulate improvements and services which may be paid for by special assessments,

*Abstract of a report by Walter Matscheck, director of the Kansas City Public Service Institute, by Municipal Administration Service.

the method of fixing the assessment, the amount of assessment, the type of property subject to assessment, etc.

There are two methods for the payment of the contractor:

(a) In cash, partly from property owners who pay the assessment in full before or just after the completion of the work, and partly from the sale of special assessment bonds. These bonds are liens against the property and may or may not be guaranteed by the city.

(b) By certificates of assessment. In this case the contractor is responsible for collections and suffers the loss of those that are uncollectible.

SUMMARY OF SPECIAL ASSESSMENT PRACTICE IN 24 CITIES

(Information obtained from questionnaires)

1. *Paving.* The method most often used in assessing paving costs is the assessment of abutting property by the front-foot method. It is used completely, however, in only four cities. In several others intersections are paid by the city and the remainder by the abutting property. In ten of these cities paving costs, including intersections, are assessed. In six all of the paving except intersections is assessed, and in the remaining eight, other methods are used. In Cleveland and Toledo the city pays intersections plus 2% of the remaining cost. In Pittsburgh and Milwaukee the assessment is to the extent of actual benefit and the remainder is paid by the city. In St. Paul the abutting property is assessed for a twelve-foot strip, the balance and intersections being paid by the city. In Newark the assessment varies according to the character of the street, the city paying as high as 80% of the cost. In Philadelphia paving on parkways, boulevards and special traffic streets is paid entirely by the city, and on other streets the city pays for intersections and for the work in front of tax-exempt property. In Baltimore part is paid by a special paving tax, part by special assessment, and the remainder by the city.

Sixteen of the twenty-four cities assess benefits on the front-foot basis, one on the area basis, and four use zones or depth curves. In St. Louis one-fourth is assessed against abutting property on a front foot basis and three-fourth against a benefit district on an area basis. Pittsburgh and Milwaukee assess on a strictly benefit basis.

In fifteen cities only abutting property is assessed. In three cities property half way to the next street is assessed, and in two, property one hundred and fifty feet from the paving. In San Francisco and New Orleans all except intersections are paid for by abutting property, intersections being assessed on the frontage of intersecting streets to a distance of one-half block from the intersections. In Duluth for the cost of paving on the short side of the block, the assessment is spread to the center of the block.

2. *Repaving.* Five cities make no assessment for repaving. In these cases it is paid either from the general city fund or from bond funds. Fifteen cities assess in the same manner as for original paving; but in three of these there is a very slight modification; in St. Louis, if a street is to be repaved within ten years, at least one-fourth of the cost must be paid by the city; in Milwaukee repaving assessments are limited to $3.00 per square yard; and in St. Paul, no repaving assessments may be made within fifteen years. In Cleveland the city must pay the cost of intersections, plus 2% of the cost of the remainder, plus an amount equal to one-half of the highest previous assessment for paving against that property. In Buffalo two-thirds of the cost may be assessed against benefited property; in Indianapolis, one-fourth may be assessed; and in Toledo, one-half is assessed. There is a tendency in both paving and repaving to modify the rigid plan by lessening the amount of assessment for paving, and dividing repaving between the city and the benefited property.

3. *Curbing and guttering.* The method of paying for curbing and guttering follows the procedure for paving assessments or is included in the cost of paving, in twenty of the twenty-four cities studied. St. Paul, however, assesses the entire cost against abutting property on a frontage basis; Denver against a district on a zone basis; Portland against abutting property except corners, which are zoned on an area basis; and in Newark the entire cost is assessed on abutting property.

4. *Sidewalks.* In every city the entire cost of sidewalks is assessed against abutting property in the same way that paving is assessed. In Cleveland and Philadelphia sidewalks are built by the property owner.

5. *Grading.* In eighteen cities the cost of grading is assessed by the same method as paving or included in the paving cost. In Kansas City, however, where the topography is rough, only sub-grading is included in this cost and main grading is generally assessed against a benefit district. In exceptionally large projects the zoning of districts is used. There is no assessment for grading in Detroit, but very little grading needs to be done. In Indianapolis grading is assessed against a benefit district and may be paid partly by the city at large. St. Paul assesses original grading against abutting property, but large jobs against a benefit district. In Des Moines, when grading is done in connection with street opening and widening, it is assessed against a benefit district; but when it is connected with a paving project it is financed from the general fund. Sub-grading is included in paving. Original grading is assessed entirely against abutting property in Newark, and large projects may be assessed against benefit districts created for that purpose.

6. *Street opening and widening.* The most common method of assessing for street opening and widening is the creation of a benefit district against which all or at least part of the cost is assessed. In the larger projects it is customary for the city to pay part of the cost.

7. *Sewers.* There is little uniformity in assessing and paying for sewers. One method used is the assessment of lateral sewers and the payment for trunk sewers from bond funds. Another is to limit the assessment against any property to the cost of a sewer sufficient to provide local service to the property, and sometimes the size of the sewer necessary to accomplish this is fixed by law. In some cases lateral sewers are assessed against abutting property and main sewers against a sewer district determined by the drainage area. It is quite common to limit the amount of assessments for sewer construction. Some cities assess on the area basis against sewer

districts drained. A very detailed table in the report gives this information for each city.

8. *Acquisition of parks and playgrounds.* In general the cost of the acquisition of land for parks and playgrounds is met by special assessments. In three cities it is common to pay this cost by assessment against benefit districts. In two others part of the cost is usually assessed by district. In four cities special assessments are allowed but very seldom used.

9. *Park and boulevard maintenance.* Kansas City is the only city of the twenty-four which uses special assessments for the maintenance of parks and boulevards.

10. *Viaducts over, and subways under, railroad tracks.* In only three cities besides Kansas City are there special assessments for viaducts and subways made necessary by railroad tracks. In Los Angeles there is a special assessment in some cases; in Seattle in very rare cases a benefit district is created for this purpose; in Portland 20% is usually assessed against a benefit district; and in Kansas City they may be paid for by the railroad, by the city at large, by special assessment, or by some combination of these methods.

11. *Trees.* In ten cities street trees are planted by the city and assessed against abutting property. In other cities, the trees are either planted by property owners or by the city; in the latter case they are financed from the general fund.

12. *Street cleaning, lighting and repair.* Toledo is the only city that has a special assessment for street cleaning. None of the cities assess the cost of street repair, Kansas City having abandoned the practice in 1923 when the gasoline tax ordinance was passed. For street lighting, fourteen of the cities have no assessments; and in the others the cost of original street lighting is paid by the city, although ornamental lights and the like are partly or wholly assessed against abutting property.

13. *Water main extensions.* No assessment is made for water mains in thirteen cities. In two others the water department is privately owned; and in the others a portion of the cost is usually assessed. A common limitation is that not more than the cost of the local mains may be assessed.

14. *Levees.* No adequate information was obtained as to the payment of the cost of levees.

15. *Paving by street railway companies.* In fifteen cities the street railway companies pay the cost of paving between the tracks and for a short distance outside. In Philadelphia and Pittsburgh the city is paid a flat sum in lieu of paving. In Baltimore paving is done on part of the system by the railway company. In Indianapolis and Seattle the companies pay the excess over the ordinary cost of paving the area. In Newark the company pays for paving when it lays new tracks and in Denver and Duluth the companies pay no paving cost. There was no information from Milwaukee. In fifteen of the cities the companies pay for repaving between and along the outer edges of the tracks. These are the same cities as the fifteen listed for original paving, except that Cleveland is omitted and Denver is included. In the remaining eight paving by street railway companies is treated in the same manner as ordinary paving. In seventeen cities the companies pay for repairing such paving. In Philadelphia and Pittsburgh they pay a lump sum and in Duluth they pay nothing. In Newark they pay part of the cost and in Baltimore the entire cost on part of the street railway system. In fourteen the company does not pay for the cost of cleaning the street railway areas, and in five it does. Lump sums are paid in Pittsburgh and Philadelphia, and the entire cost is paid over part of the system in Baltimore.

16. *How is the contractor paid?* Payments to the contractor are paid in cash or by tax bills or certificates. For cash payments, funds are raised by the city from collection of assessments, from the sale of bonds or certificates, or from city funds. In the second method, tax bills or certificates are given to the contractor as evidence of the special assessment against certain property. These are in the amount of the special assessment against the specific property benefited and the contractor is responsible for their collection. The cash method is used in fourteen cities and the certificate method in five cities. In Philadelphia the certificate method is used except for water main assessments. In Los Angeles it is used in 95% of the cases, and the cash method in 5%. In Buffalo the contractor is paid in warrants payable by the city in from one to five years but callable at any time. In Omaha cash payment is generally used, and in Pittsburgh the contractor is paid by an assignment of the amount due him. The city pays this assignment from special assessments as they are collected, but it must pay the full amount in two years. Unpaid portions of the assignment bear 6% interest.

Assessments may usually be paid in more than one installment unless they are very small in amount. The number of payments varies from one to twenty. The interest rate on unpaid assessments ranges from 5% to 7% and sometimes 8% on delinquent installments.

17. *Benefit districts and zones.* Boundaries of assessment districts are usually fixed by the council with certain exceptions. Sometimes they are determined by a city board, by some city official, or by a special commission.

## Permanence of Photographic Records

Copies of deeds, wills, and other public documents, of maps and the like are made more accurately, cheaply and quickly by means of photography than probably in any other way. The question, however, has been raised as to how long the copies will last. The facts recorded by them are generally matters for permanent record, and if photography will not effect this as certainly as other practicable means, it should not be employed.

Hand-written and typewritten records do not last forever; faded ink, broken binding, torn, soiled and loose pages, and paper turned brittle are common reasons for recopying records; and the question is not whether photographic records will last forever, but how their life will compare with that of records made by other methods.

Last year the Bureau of Municipal Research of Philadelphia obtained opinions on this point by means of a questionaire from about 100 users of the photographic method of copying, including recorders of deeds, registrars of wills, secretaries of state, bureaus of the federal government, public

libraries, railroad companies, banks, etc. Opinions also were obtained from persons who had made tests of the durability of photographic paper and from those familiar with paper making and the chemistry of photography. The Bureau, in reporting on the questionaire, states that the replies gave little if any ground for doubt. Most of them stated that no deterioration was observable in the photographic records in their offices, although some of the photographic records referred to in answer to the Bureau's questionaire are thirty years old.

There seems to be no doubt that photographic prints can be made so that they will not fade.

The durability of photographic paper is largely dependent upon the durability of the "basic" paper, that is, the paper before it is sensitized. It is possible to get photographic papers in which the basic paper is the same as recording officers use for handwritten and typewritten copies. The question remains, will the photographic prints, on the most durable basic paper obtainable, last as long as handwritten or typewritten records on the same basic paper? Only time will give the final answer to this question—just as only time will give the final answer as to the permanence of a record made with a particular bottle of ink, or particular typewriter ribbon, or on a particular grade of paper.

Whatever the method, there will be things which a recording official must take on faith. Many public officials and communities, after careful investigation have been convinced and have acted on the conviction that photographic paper will stand at least as much usage and exposure as the basic paper. Only three who answered the Bureau's questionaire expressed any doubt on this point, and apparently these three did not consider their objection serious enough to offset other advantages of photography. The objection was that creasing would damage a photographic print more than an ordinary piece of paper. It is noteworthy that this objection came from commercial concerns, which presumably do not use the grade of paper that would be used for permanent public records and which probably subject the prints to more folding than would occur with records bound in heavy-covered books.

# Novel Sewage Treatment Methods in Small Plant

**Modified Imhoff tank with sprinkling filter and cylindrical sludge digestion tank, with capacity of 250,000 gallons. Sprinkling filter without side walls.**

A plant has been built recently in Maryland with a normal capacity of 250,000 gallons for 24 hours for a population of 2,500 people which, while it is of the usual sprinkling filter type with sedimentation preceding and following, has as rather unusual features the application of separate sludge digestion, and the adoption of a modified form of Imhoff tank for primary and final sedimentation, which construction resulted in a saving in cost.

The plant serves Gaithersburg, with a population of about 1,300, and Washington Grove, with a summer population of about 700, which are about a mile apart. About two-thirds of the sewage of Gaithersburg drains to the treatment works by gravity, but the sewage from one-third of Gaithersburg and all of that of Washington Grove is pumped at four small pumping stations. There are 7.2 miles of collecting sewers and an outfall 1.2 miles long of 12-inch and 15-inch pipe, with 430 feet of an 8 inch inverted siphon.

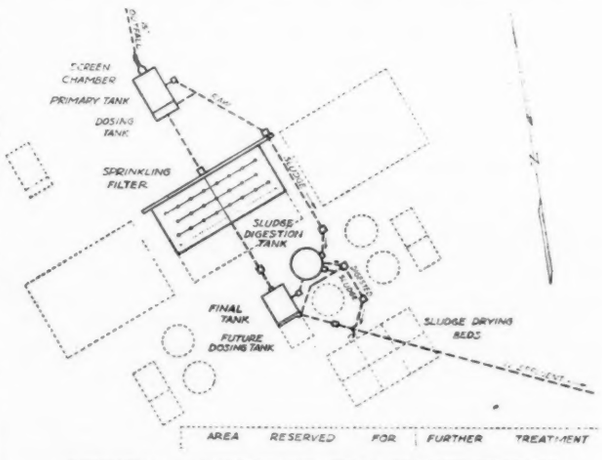
The outlet is into a stream with a water shed of 2.5 square miles, which flows through dairy farms and consequently a complete purification method was considered necessary.

As no electric current was available anywhere near the site, it was thought advisable to keep the plant free from machinery, such as is required for activated sludge treatment or mechanical removal of sludge.

The plant, as designed and now nearing completion, is composed of a small screen chamber at the inlet of the primary sedimentation tank, primary tank and dosing chamber, sprinkling filter, final sedimentation tank, sludge digestion tank, and sludge drying beds. Only one-half the sprinkling filter and one sludge tank for one-half the capacity of the plant are being built at this time. The effluent from the final tank will be discharged directly into Muddy Branch. Sludge beds for one-half the capacity of the plant are to be built this summer.

In the present construction of a part of the plant, the units are balanced, so that any expansion will involve completely new units of each kind, and not an increase in size of one or the other. It is believed that this feature allows the greatest amount of latitude in the future design and will permit the fullest advantage to be taken of later improvements in methods of sewage disposal.

*Design of Sedimentation Tanks.* In studying the



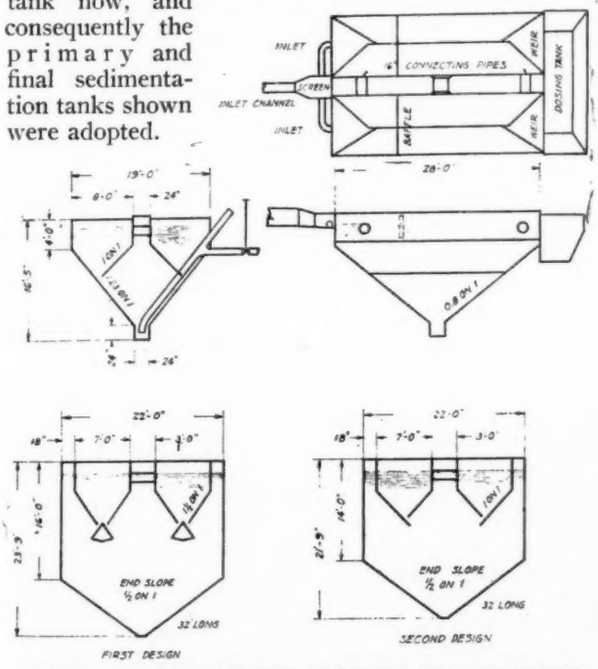

GENERAL LAYOUT OF TREATMENT WORKS.

plans for primary and final sedimentation tanks, the first design studied provided for Imhoff tanks with sedimentation periods of 1½ hours and 1 hour and sludge capacities of 2 and 1 cubic feet per capita respectively; with slopes on the inner walls separating the sedimentation and sludge digestion compartments of 1½ on 1, and a maximum bottom slope of ½ on 1. A discussion by this association last year of a paper by Mr. Schaetzle on the use of flatter inner-wall slopes led to a revising of the design with inner wall slopes changed to 1 on 1. This permitted decreasing the total depth of the primary tank by 2 feet and of the final tank by 1 ft. 9 inches, with a total saving in cost of nearly $2,000.

A third type involving separate sludge digestion was then considered. The two-story type of tank and the same period of sedimentation were kept, but the sludge compartment was reduced in size to retain sludge over a short period only, until it could be removed to the digestion tank. This further reduced the depths of both tanks by 5 ft. 4 in. and 3 ft. 4 in. respectively, or a total reduction from the first plan of 7 ft. 4 in. and 5 ft. 2 in. respectively.

The three plans for the primary sedimentation tank are shown in the accompanying illustration. The final sedimentation tank was designed along the same lines but of somewhat smaller dimensions, the outside dimensions of the final plan being 17 ft. by 23 ft. 6 in. by a total depth of 14 ft. 7 in.

Comparisons of cost showed that the modified form of Imhoff tank, together with the necessary sludge digestion tanks with the same sludge capacity as the combined capacities of the primary and final Imhoff tanks previously studied, could be constructed at a saving in cost of approximately $3,000 over the first tank design, and $1,000 over the second. This saving on such a small installation was too great to be ignored, particularly as even a greater saving in first cost could be made by building only one sludge tank now, and consequently the primary and final sedimentation tanks shown were adopted.




ABOVE—CROSS-SECTIONS ADOPTED FOR PRIMARY SEDIMENTATION TANK.
BELOW—CROSS-SECTIONS CONSIDERED FOR THIS TANK.

*Screen Chamber, Primary Sedimentation and Dosing Tank.* Before entering the primary tank, the sewage flows through a small screen chamber 5 ft. long, 3 ft. wide, 2 ft. deep with a sloping bottom, containing a bar screen composed of ½ in. by 1⅛ in. bars with a clear opening of 1½ inches, set at an angle of 35 degrees with the horizontal.

The primary tank has a theoretical detention period of 1½ hours, based on the average sewage flow. The sludge reception compartment has a capacity of 309 cubic ft. below the slots. The two sedimentation chambers, which are separated by a central compartment corresponding to the gas vent of the Imhoff tank, are connected near each end by a 16-in. pipe to minimize short-circuiting through the slots in case the level in one chamber should become higher than in the other.

The slots were made 6 in. wide. With the long sloping outside walls it will be possible to scrape them all the way to the bottom of the tank and thus provide agitation for the sludge in addition to cleaning the walls.

On entering each tank, the sewage passes under a baffle, and flows from the tank directly into the dosing tank over a full-width weir at the outlet end of each chamber. Sludge is removed by hydraulic pressure through an 8-in. pipe projecting into the sump at the bottom of the tank with its outlet 4 feet below the sewage surface, and is conveyed through a pipe directly to the digestion tank. To assist the flow of sludge, settled sewage can be delivered directly to the sludge line by opening a gate in the dosing tank which controls a connection to the sludge line.

The dosing tank has a capacity of 3,400 gallons and is provided with a single 10-inch Miller trapless siphon for automatic intermittent application of the settled sewage to the sprinkling filter under a maximum head of 6.6 ft. above the sprinkler nozzles. The screen chamber, primary sedimentation tank and dosing tank are built as one structure.

*Final Sedimentation Tank.* This is similar to the primary tank but has a theoretical detention period of 1 hour based on the average sewage flow. The sludge compartment has a capacity of 180 cu. ft. The effluent from this tank is discharged directly into Muddy Branch.

*Sprinkling Filter.* This is approximately 42 ft. 3 in. by 90 ft. 6 in. as built, but will be increased to 69 ft. 6 in. by 90 ft. 6 in. with an effective stone area of 4,116 sq. ft. The rate of application, based on the average sewage flow, is 2.65 million gallons per acre daily. The filter medium is limestone vary-

PRIMARY TANK UNDER CONSTRUCTION.

ing in size from 1 in. to 2½ in. and with an average depth of 5.6 ft.

A 4 in. concrete slab underlies the entire bed. For a distance of 6 ft. in from the edge it was covered with two coats of Inertol. The stone is sloped at 45 degrees on three sides of the filter instead of being confined by a wall. This increased the amount of stone filtering material and the concrete bottom slab, but resulted in a net saving of $400 on the half unit.

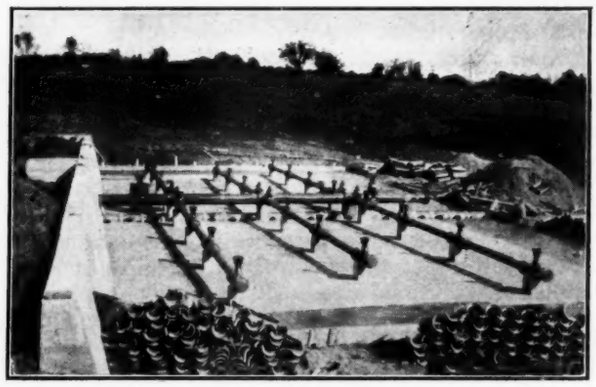
The clarified sewage is distributed through a 12 in. cast iron main running lengthwise through the center of the bed and twelve 6-in. lines feeding thirty-eight full-spray and eight half-spray ⅞-in. nozzles spaced 10 ft. 6 in. on centers, through 3-in. vertical risers. The distributing piping is laid about 3 ft. 6 in. below the surface of the stone, supported on concrete piers, in order to provide some protection against freezing of the lateral lines during the early winters of the plant when the discharge periods of the siphon are far apart.

The underdrainage system consists of the ordinary plan of 6 in. vitrified split pipe in 2-ft. lengths, inverted, with 1-in. open joints, laid on the concrete bottom at approximately 2 ft. centers. These extend from the outer edge of the stone to the main underdrain, with the ends open for inspection and cleaning. The main underdrain is composed of 12-inch by 6-in. vitrified double T-branches, and manholes at the upper and lower ends of this drain provide for inspecting and cleaning it.

*Sludge Digestion Tank.* This was designed for 1,250 persons at 3 cu. ft. of sludge per person. It is cylindrical in shape with a conical bottom, the slope of which is 0.57 on 1. The cylinder is 22 ft. in diameter and the sides 11 ft. 9 in. deep, with a maximum inside depth of 17 ft. 9 in. Sludge from the sedimentation tanks is discharged into the digestion tank near the center and about 6 ft. below normal water surface. Provision is made for removing supernatant liquid through valved outlets at 0.2, 2.0 and 3.9 ft. below normal water level. This liquid will be discharged onto one of the sludge drying beds which will have a greater depth of sand for this purpose than the others.

Agitation of the sludge will be effected by the use of a scraper working on the sloping bottom. No sludge drying beds have yet been constructed but it is expected to do so this summer. Three will be built at first, each 20 ft. square, designed for 1 cu. ft. of digested sludge per person. They will consist of 12 in. of graded gravel and 6 in. of sand overlying underdrains of 4-in. open-joint unglazed farm tile laid 6 ft. 8 in. apart.

PLACING LATERAL UNDERDRAINS AND STONE IN SPRINKLING FILTER.



SPRINKLING FILTER BEFORE LATERAL UNDERDRAINS WERE PLACED.

With the exception of the sludge beds, the cost of the work as planned for first construction will be about $23,500, and the estimated cost of the three sludge drying beds is about $2,200. Based on the bid unit prices, the estimated cost of the completed plant with all units brought to full size is approximately $37,600. These figures include engineering and administration, but no land or rights of way.

This plant was designed and the construction supervised by the engineering force of the Washington Suburban Sanitary District, of which Robert B. Morse is chief engineer, under the immediate direction of Harry R. Hall, deputy chief engineer of the district, who described it recently in a paper before the second annual convention of the Maryland Water and Sewerage Association, of which paper the above is an abstract. The construction department of the district, of which H. Roland Devilbiss is department engineer, immediately supervised the construction work, while Noble L. Owings was engineer in charge of the work. The contractor was Ligon & Ligon of Baltimore.

## The Camera in Highway Construction

Hereafter the engineers of the New Mexico State Highway Department will be equipped with cameras and will obtain, in addition to the notes always required, a complete photographic record of each Federal aid project from the time of its inception until its completion, and even during the period of maintenance.

This idea the department has borrowed from the U. S. Bureau of Public Roads, which adopted it several years ago. The strict requirements and close supervision of the bureau on the one hand and the State's relation with the contractor on the other make this move advisable. Photographs taken during construction will furnish a permanent, unbiased and incontestable record concerning earth classification, condition of the ground during bridge and foundation excavation, character of borrow pits, etc.

Recently such a pictorial record was used as supporting evidence in the classification of earth work on an entire Federal aid project to the satisfaction of every party involved.

## President Vetoes Health Service Bill

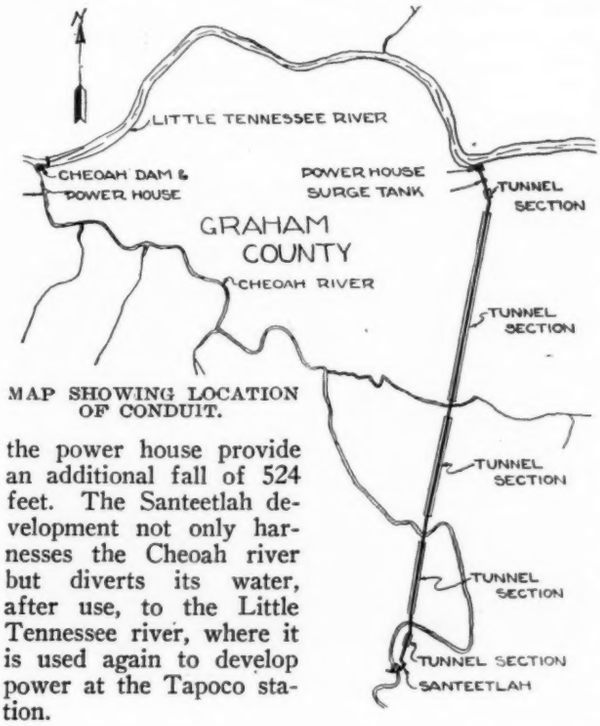
President Coolidge on May 21 vetoed the bill, referred to by us editorially in our March issue, "to provide for the coordination of the public health activities of the Government." The chief reason given was that the Attorney-General advised that it would be unconstitutional to vest in a board of officers and the Surgeon General appointment of officers of the United States.

# Constructing Tallassee Conduit

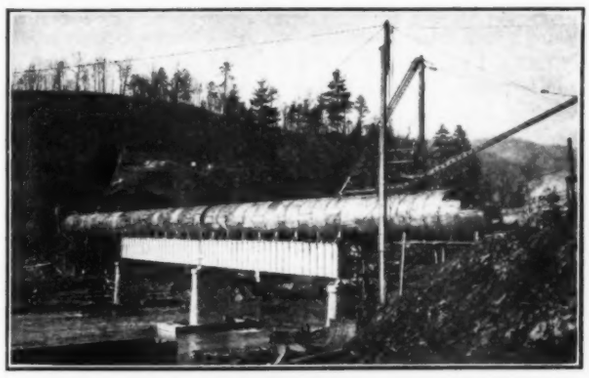
**Constructing eleven-foot steel pipe line through tunnels and over rivers, and surge tank 163 feet high.**

The Tallassee Power Company is constructing in Western North Carolina an eight million dollar hydro-electric project consisting of a dam in the Cheoah river at Santeetlah, approximately five miles of tunnel and steel pipe, a surge tank, a 50,000 k.w. generating station at Rymer's Ferry, and a transmission line.

This project is a second unit in the company's plan to develop the power facilities of the Little Tennessee river and its tributaries. The accompanying diagram shows the general plan of the Santeetlah development. The spillways of the dam are at an elevation of 1,815 feet and the tailrace at 1,154 feet, giving a maximum operating head of 661 feet when water is flowing over the dam. The conduit, which takes water from a point in the dam 75 feet below the spillways, has a fall of 62 feet to the surge tank. Two penstocks between the surge tank and the power house provide an additional fall of 524 feet. The Santeetlah development not only harnesses the Cheoah river but diverts its water, after use, to the Little Tennessee river, where it is used again to develop power at the Tapoco station.




MAP SHOWING LOCATION OF CONDUIT.



FIRST RIVER CROSSING

The Tallassee Power Company built the dam, power house and other construction work with its own construction department. Some of the more special work, such as tunnels and steel pipe, was performed by outside firms under contract. The fabrication and erection of approximately 8,600 feet of 11-foot steel pipe and a surge tank 32½ feet in diameter and 163 feet high was let to the Chicago Bridge & Iron Works.

The country between Santeetlah and Rymers Ferry consists of alternate mountains and valleys, necessitating five tunnels totaling approximately four miles to carry the conduit. The steel pipe extends entirely through the first and fifth tunnels. In the other tunnels the pipe is extended only a short distance inside the portals, the distance depending upon the character of the rock formation; the remaining length of these tunnels being lined with concrete having a minimum thickness of nine inches.

The steel section of the conduit is constructed of plates ranging from ⅜ inch to 11/16 inch in thickness. The heavier plates have triple riveted butt-strap joints. The tunnels were made very little larger than the pipe, making it impossible for the joints to be riveted with the plates in place. The pipe was therefore asembled and riveted in 45-foot sections outside the tunnel, and these were skidded into place and then welded together from the inside. The space between the pipe and the tunnel wall was then filled in solid with grout forced through nipples left at intervals in the pipe for that purpose.

The erection of this portion of the work was under the direction of F. C. McCloud as foreman and S. Anderson. They had an average crew of 80 men during the time that the work was progressing normally.

One of the principal difficulties in the construction of the pipe line was the transportation of the material to the point where it was used. Although the conduit is only five miles long, the shortest route overland is some 9 miles, and that is only a foot trail a portion of the way. Surrounding mountainous country is equally inaccessible and the only points where material could be delivered were at the dam and the power house.

The material used in the portion of line nearest the dam was shipped direct to Santeetlah over a railroad operated from Calderwood, Tenn., by the power company; but that for erection near the power house end had to be taken from the cars at Tapoco.

hoisted over the dam at that point onto barges and pushed five miles up the Little Tennessee river to Rymer's Ferry.

Wherever possible the plates were dragged to the site, hoisted into position with a travelling derrick, bolted, reamed, riveted and calked. The derrick was mounted directly on the portion of the pipe already erected and moved along about 30 feet at a time by means of a hand crab. The boom was swung by a hand winch and the boom and fall lines operated by two small air hoists.

The pipe is supported at 30-foot intervals on steel cradles and reinforced every 30 feet with stiffeners. Where the pipe runs parallel and close to the ground, the cradles are short plate and structural saddles resting on concrete piers. At ravines the supports are structural steel bents from 12 to 50 feet high. At the two Cheoah river crossings the saddles are mounted on plate girder bridges resting on concrete piers.

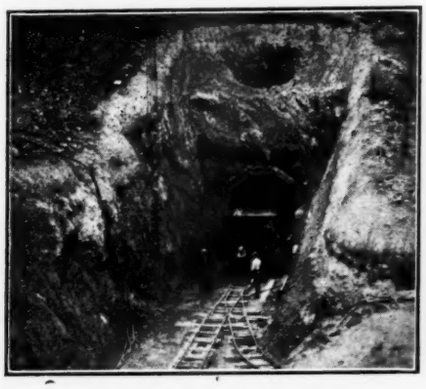
At each bend or change of direction the pipe is anchored in concrete. There are twelve expansion joints throughout the pipe line, each section between anchor points having one or more. They are of the slip type and built of structural steel with sliding surfaces of monel metal for protection against rust.

The surge tank, a Johnson differential type, is built at the end of the 11-foot pipe line just as it emerges from the last tunnel. It is 163 feet high, one of the highest standpipes ever built by the contractor. The tee in the pipeline underneath the surge tank has a 9-foot vertical section which terminates at the base of the tank. A 7-foot downcomer is set over this 9-foot opening and extends to the top of the tank. The one foot space around the downcomer at the bottom is partially closed with concrete, leaving ports to feed the water back into the line.

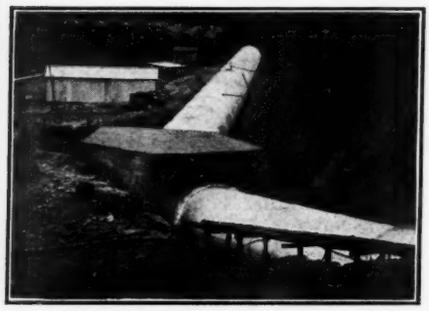
A wye is located just below the surge tank, from which two 8-foot penstocks lead to the power house with a fall of over 500 feet. The wye itself is 37 feet long and constructed of ¾ inch plates with ⅞ inch and 1⅛ inch rivets.

The inside of the pipe and surge tank were given two coats of red lead in the field; the outside, one coat of red lead and two coats of aluminum paint.

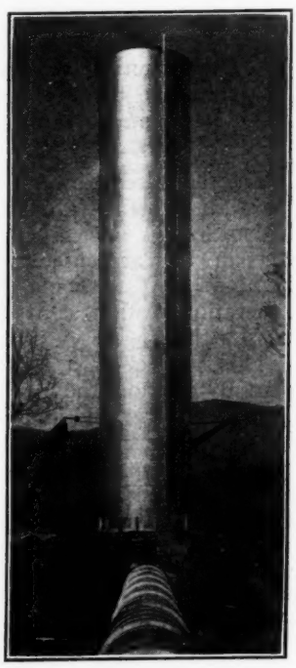
The above description is from "The Water Tower," a publication of the Chicago Bridge & Iron Works, and we are indebted for the illustrations and permission to publish it to M. E. Smith, of that company, the author of the article.



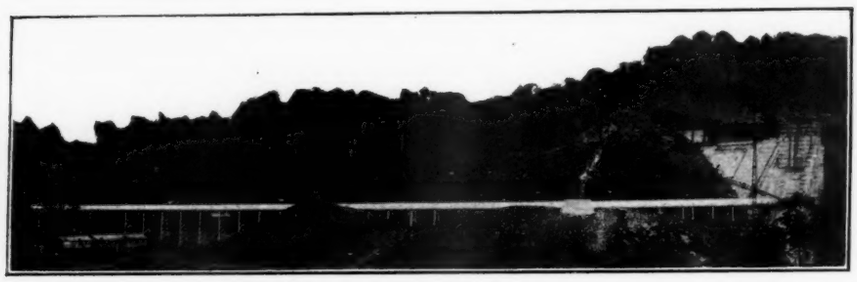
HAULING STEEL PLATES THROUGH TUNNEL.



CONCRETE BLOCK TO TAKE THRUST AT ANGLE IN LINE.



SURGE TANK.



PIPE LINE SUPPORTED ON STEEL BENTS. DAM AT RIGHT.

WYE AND SURGE TANK RISER.

# Recent Legal Decisions

### WATER RATES TO CONSUMERS OUTSIDE CITY

Out-of-town consumers of a municipal water utility, although obtaining a measure of fire protection, pay no city tax, so that the Wisconsin Railroad Commission holds, in authorizing an increase of Oconomowoc water rates, such consumers may properly be served at rates sufficiently higher than city rates to compensate for the protection furnished. If the city chooses to supply water to its citizens at cost or substantially so, it is under no obligation to serve outside the city on the same basis.

### FREE WATER SERVICE TO CITY BY MUNICIPAL WATER PLANT DISAPPROVED

The Montana Public Service Commission, Spangler v. Great Falls Municipal Water Plant, holds that a city, as trustee of the water plant for all the consumers, should stand in the same relation to it as any private individual and should not receive service without compensation.

The taxpayers, it holds, "are reasonably entitled to be compensated for the use of the general credit of the city by being permitted to earn a return if they so desire upon the utility property equal to the return which a private company would have to have, and which would constitute a fair return for such company. It is proper to make adequate provision for the future, though rates should not be so high as to recruit capital which ought to come from the tax payers instead of the rate payers. Broadly speaking, the rate payers' duty is to pay for the use of the plant; the tax payers' duty is to contribute the necessary capital."

The Wisconsin Railroad Commission holds, In re Village of Oregon, that a village operating its own water works should pay into the water fund annually sufficient to cover the cost of fire protection service rendered by the water department.

### RIGHT OF DISPOSAL OF MUNICIPALITY ELECTRIC LIGHT PLANT

Property such as an electric light plant held by a municipality is so held in trust for the use and benefit of its citizens and is dedicated to the use of the public. The municipality cannot divest itself of the title without special authority from the Legislature. —Worcester Electric Co. v. Hancock, Maryland Court of Appeals, 135 Atl. 832. A city's contract right to purchase such a plant could be sold by the city under its general power to sell and convey property which has not been dedicated to public use.

### ASSESSMENT OF PROPERTY OUTSIDE A CITY BENEFITED BY SEWER WHOLLY WITHIN THE CITY

The Indiana Appellate Court holds, Wilhelm v. City of Indianapolis, 154 N. E. 496, that statutes relating to the construction of sewers or drains extending through, into, or affecting towns wholly surrounded by a city or contiguous thereto, do not apply to the assessment of property in a town outside the city for the construction of a sewer wholly inside the city if the sewer benefits the property assessed. The fact that the property is distant from the sewer and not connected with it is no legal reason why it should not be assessed; but that fact would affect the amount of the assessment, and it is to be presumed the assessors would consider the fact in making the assessment.

### SEWAGE DISPOSAL PLANT NEAR RESIDENCE NOT A NUISANCE PER SE

Suit was brought to enjoin the city of San Angelo from erecting and maintaining a sewage disposal plant on lands owned by the city about 2½ miles from the city limits and about 800 feet from land on which complainants proposed to erect a residence, on the ground that the plant would constitute a permanent nuisance. The Texas Court of Civil Appeals held, Boyd v. San Angelo, 290 S. W. 833, that sufficient evidence had not been introduced to support a finding that the plant would be a nuisance.

A sewage disposal plant, when located near a private residence, does not constitute a nuisance per se. A proper disposition of a city's sewage is essential to the health and welfare of its population, and affects the entire community. The Legislature has therefore recognized the necessity for such plants, and has vested cities with power of eminent domain, to condemn lands both inside and outside the city limits for the construction and operation of such plants. Texas Rev. St. articles 1175, 1107, 1108. The location and manner of operation of the plant must determine the question of whether it is a nuisance. And even when it becomes a nuisance it does not necessarily follow that such nuisance is permanent, or that its operation may be permanently enjoined.

It was not shown that the plant could have been located elsewhere with less inconvenience or discomfort to others, and complainants could not claim relief without showing that the public convenience was outweighed by their discomfort and the damage to their property. If it was damaged, they had their remedy at law.

### CONTRACT FOR CULVERTS EXCEEDING ANNUAL REVENUE HELD UNENFORCEABLE IN ARKANSAS

Under Amendment 11 to the Arkansas Constitution (Laws 1925, p. 1086) a county cannot incur any obligation in any year exceeding the revenues of that year, and if this is done, such obligations are void and cannot be paid out of the revenues of a succeeding year. It was therefore held, Dixie Culvert Mfg. Co. v. Perry County, Arkansas Supreme Court, 294 S. W. 381, that a contract with a county for culverts purchased and used in 1926, to be paid for during the ensuing year, was invalid and unenforceable, notwithstanding an order of the county court showing that it was imperative to purchase such material and use it for culverts to drain the roads and prevent them from being greatly damaged.

### INJUNCTION OF MAINTENANCE OF SEWAGE DISPOSAL PLANT

The Texas Court of Civil Appeals, City of Marlin v. Criswell, 293 S. W. 910, affirmed decree granting injunction to restrain the city from operating its present sewage disposal plant and from enlarging the plant and requiring it to move the plant to some other locality. The evidence was held sufficient to support the jury's finding that the present plant gave off obnoxious odors disturbing to the property owners complaining, and that the proposed new plant would probably have the same result. Testimony as to odors and gases escaping from similar plants in other localities was held admissible.

### "LABOR PERFORMED" WITHIN NEW JERSEY PUBLIC WORKS BOND

Furnishing trucks and the carting therein of cracked stone and sand from the quarry to the site of the construction of roads, etc. for a county is "labor performed" within the contractor's bond under the New Jersey statute. Hammill v. Commercial Casualty Ins. Co., New Jersey Supreme Court, 137 Atl. 884.

### DAMAGES FOR BREACH OF CONTRACT FOR FILLING

A contractor contracted to do all filling required on a specified street improvement at $1.50 per cubic yard. He sub-contracted for the work at $1 per cubic yard. The employer breached the contract by refusing to permit the contractor to do it. In an action therein the proofs showed that the amount of filling to be done would be about 13,000 cubic yards. The defendant contended that a verdict for the plaintiff of $6,000 was excessive. As the contractor would have made a profit of 50 cents per cubic yard on his sub-contract, it was held that the award was justified. Robinson v. Mellon, New Jersey Supreme Court, 137 Atl. 924.

### VALIDITY OF LOCAL PAVING ORDINANCE AND ASSESSMENT

The New Jersey Supreme Court holds, Kalita v. City of Perth Amboy, 135 Atl. 679, that an ordinance authorizing a local paving improvement was not invalid because it did not state that assessments therefor would be levied on property in the vicinity thereof, or specify the proportion of the cost to be assessed against such properties, or because no notice was given the property owners of the intention to pave, in the absence of statute requiring same. The passing of the ordinance on its first reading before notice of intention to consider was published would, under the statute, be fatal to its validity, but the ordinance could not be attacked on this ground after the improvement was completed and the assessments confirmed.

### TEXAS COMPENSATION ACT NOT APPLICABLE TO MUNICIPALITIES

Texas Workmen's Compensation Act does not, it is held, apply to cities and towns, and the act does not deprive a municipal corporation employer of its common law defenses. City of Tyler v. Texas Employers' Ins. Assn., Texas Commission of Appeals, 288 S. W. 409.

### CLAIM FOR MONEY DUE ON ROAD CONTRACT ASSIGNABLE

A claim against a county for money to be paid for building a public road may be assigned by the contractor to a bank to obtain money to pay for labor and material used on the road, and the bank can maintain an action against the county to recover on the claim.—Citizens' State Bank v. Board of Comrs. of Cheyenne County, Kansas Supreme Court, 252 Pac. 228.

### PROTECTION OF MATERIALMEN UNDER ROAD CONTRACTOR'S BOND

The road contractor's bond required by Mississippi Laws 1918, c. 217, protects materialmen whether the materials are furnished directly to the contractor or to another who performs the work for him, and they are protected where, after giving the bond, all but one of the contracting firm retire from it, and the remaining partner performs the contract. —Excello Feed Milling Co. v. United States Fidelity & Guaranty Co., Mississippi Supreme Court, 111 So. 94.

### EFFECT OF ASSIGNMENT OF FUNDS TO BE PAID FOR ROAD CONSTRUCTION

A written assignment of the funds to be paid by the Oklahoma highway commission to the builder of a highway before the project is completed operates as an equitable assignment and transfers the title to the pledgee when the money becomes due. The assignment impresses the money with an equitable lien when it becomes due, and this lien is superior to the claim of a general creditor.—M. Coy v. First National Bank, Oklahoma Supreme Court, 252 Pac. 404.

### ACCEPTANCE OF ROAD CONTRACT BY COMMISSIONERS NOT SET ASIDE BY FALSE STATEMENTS OF CONTRACTORS AS TO ITS COMPLETION

The Indiana Supreme Court holds, State v. Martin, 154 N. E. 284, that the mere fact, if it were a fact, that road contractors told the engineer and superintendent and members of the board of commissioners that they had fully performed the contract according to its terms and the specifications, when they had failed to fill up certain mud holes so as to constitute a permanent foundation, and had failed to cover the ground with broken stone to a sufficient depth before laying the bricks, and had used second grade bricks instead of the first grade contracted for, would not constitute fraud upon allegation and proof of which judgment by the board that the contract was fully completed, entered after hearing evidence, would be set aside.

### HIGHWAY CONTRACTORS' BONDS; LIMITATION OF TIME FOR ACTION

Coal furnished a highway contractor to run the steam shovel loading shale on trucks to be hauled on the roadbed was not covered by the Arkansas statutory public statute, C. & M. Dig. §§6913, 6914.

An action on such a bond brought eight months after completion of the highway and its acceptance by the county was barred by the state statute of limitations. Southern Surety Co. v. Simon (Ark.) 290 S. W. 960.

—Almon L. Fales, Chairman, Metcalf and Eddy, Boston, Mass; Standardization of Pipe Fittings and Flanges—F. A. Barbour, Chairman, Hydraulic and Sanitary Engineer, Boston, Mass; Simplification and Standardization of Manhole Frames Covers—Frank A. Marston, Chairman, Metcalf and Eddy, Boston, Mass; Standard Form of Contract—J. Waldo Smith, Chairman, Board of Water Supply, New York.

### AMERICAN WATER WORKS ASSOCIATION—NEW YORK SECTION

The spring meeting of the New York section of the American Water Works Association was held at Utica, N. Y., May 3 and 4.

E. K. Wilson, chief engineer of the Pitometer Co., opened the discussion of the "Distribution Systems" section of the Water Works Manual by suggesting a more precise definition for the term "large mains," since a large main in a small city might be considered a small main in a larger place. He also suggested a complete bibliography at the end of each chapter. He was followed by J. A. Wode of the Federal Water Service Corporation, who suggested condensation of the space devoted to "pressure conduits" and to separate fire protection systems," and an expansion of the material devoted to "carrying capacity pipes." R. J. Newson, F. J. Kemble, J. W. Ackerman and J. P. Butterfield also discussed this section.

Harry F. Huy suggested a rearrangement of the subjects in the section on "Finance and Management." J. W. Ackerman also discussed this section. A. C. Hutson of the National Board of Fire Underwriters, discussed the section on "Fire Protection," stressing the value of plant duplication and the value of fire flow tests.

Subjects covered at the second day's sessions included "The Development of a Municipal Water Supply," by J. A. Korschen of Middletown, N. Y. C. W. Sherman read a paper on "Cross Connections," which was discussed by Earl Devendorf, Harry F. Huy, J. W. Ackerman, Dr. H. J. Ball, and T. A. Cole. The final paper was "Protection of Public Works," by Robert C. Wheeler.

J. W. Ackerman, City Manager of Watertown, N. Y., was elected Section Governor.

### ALLIED CONSTRUCTION INDUSTRIES COMMITTEE

*Allied Construction Industries Committee* describing conditions in the construction industry as "seriously demoralized," leading builders from all parts of the country have organized the Allied Construction Industries Committee "to correct improper practices and to stablize credit conditions." The new body is composed of representatives of general contractors and subcontractors.

Loose credits and mushroom growth of construction companies were cited as the leading cause for wasteful, delayed and faulty construction operations.

The organization includes members of the executive committee of the Associated General Contractors of America and two representatives of each of the following trade organizations: United Roofing Contracters of America, National Association of Sheet Metal Contractors, Elevator Manufacturers Association, Heating and Piping Contractors National Association, International Association of Master Painters and Decorators of America; National Association of Building Trades Employers, Association of Electragists, National Association of Master Plumbers, International Cut Stone Contractors and Quarrymens Asociation, National Association of Marble Dealers, Contracting Plasterers International Association and Tile and Metal Contractors Association of America.

### AMERICAN ROAD BUILDERS' ASSOCIATION AND ROAD SHOW

The 1929 Convention and Road Show of the American Road Builders' Association will be held in Cleveland, Ohio, during the week of January 14th.

Extensive additions to the Cleveland Public Auditorium have been completed and will afford facilities for the Convention program and the Road Show to be held simultaneously in the Auditorium.

## PERSONALS

J. M. Fourmy has been appointed engineer for the Louisiana State Highway Commission.

Edwin J. Fort has been made city manager of Englewood, N. J., under the new form of government recently established. Mr. Fort was formerly chief engineer of sewers of the borough of Brooklyn, New York.

R. E. Lawrence, Assistant Engineer of the Kansas State Board of Health, has recently resigned after two years of service. He has been employed by Chanute as city engineer and will also act as chemist in charge of water purification.

E. F. Murphy, formerly commissioner of public works of Boston, Mass., died April 23.

## TRADE PUBLICATIONS

*Controlling Crusher Wastes With Woven Screens.*—The Ludlow-Saylor Wire Company, St. Louis, Mo.—This booklet contains a discussion of screen openings, including a comparison of square screen openings with the larger round openings required to make the same separation. Interesting illustrations show why a square-hole screen has more holes and greater capacity than a round-hole screen of the same strength for the same separation. A useful feature in the tabular pages is an index of the capacity of each of the various grades of square-mesh screens in the form of a column showing the number of screen openings per square foot of screen area.

Under another heading a demonstration is given of the longer cascades of material occuring in woven revolving-screen sections, as contrasted with the smoother perforated sections, showing why woven revolving screen sections have greater capacities and make better separations. The data are amplified with photographs and flow-sheets of actual applications of the principles of screening with woven square-mesh screens. Copies of this booklet will be sent without charge or obligation.


20 Minutes
To Replace
or Readjust

ADJUSTABLE
MANHOLE TOP

Without digging

Reduces Expense of
Street Maintenance

Proven Efficiency by
Years of Actual Experience

SPECIALTIES in Municipal
Castings for Street Service

S. E. T. VALVE &
HYDRANT CO.
50 Church St. New York City

STEWART SEWER
CLEANING MACHINE
Used in Nearly Every
State in the Union
SEWER RODS
We will pay freight and ship for
trial. Who else will do it?
W. H. STEWART
1614 Locust St., St. Louis, Mo.
133 George St., Boston, Mass.

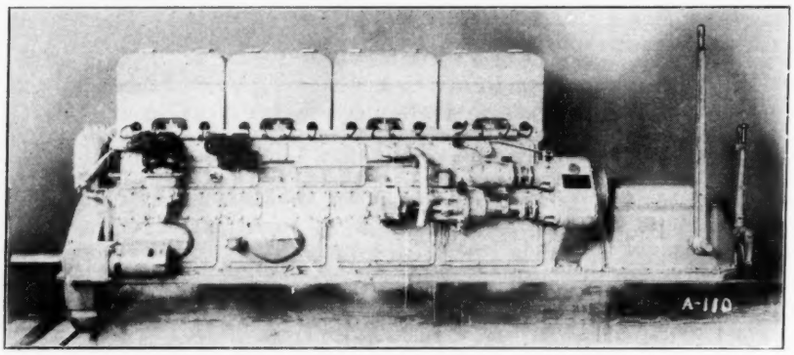
# New Appliances

**Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations**

### LARGE STERLING GASOLINE ENGINES

The Sterling Engine Co., Buffalo, N. Y., is now constructing a number of large bore high speed and high duty gasoline engines. These are six and eight cylinder engines with 8-inch bore, 9-inch stroke, developing in a six cylinder model 425 horsepower at 1200 revolutions, and 565 horsepower in the eight cylinder at 1200 revolutions.

The new Sterling engines are built with iron crank cases and weigh about




STERLING ENGINE CO. VIKING "8"

15 pounds per horsepower, excluding battering, but including electric starters and generators. Crank shaft follows the usual Sterling practice of being very large in diameter, 4 inches, with extra long bearings, having a total effective length of 22¼ inches in the six cylinder model. These bearings are fitted without shims, entailing the most accurate workmanship and the most rigid construction. The crank shaft is counter-weighted and dynamically balanced. The cylinder casting is a long water jacket in which the cylinder walls are inserted. This construction enables the marking of more perfect cylinder castings, and, with the removable cylinder walls of uniform thickness, they run at an even temperature, thereby assuring better fitting pisons for many years. The cylinders project down into the upper crank case, guiding the piston the full length of the stroke.

A full force feed oiling system is employed to all main bearings, connecting rod bearings and cam shaft bearings and to the piston pin. This oil is forced through a cooler attached to the side of the cylinder block and also strained through oil purifiers. The cooling system consists of a very large bronze water pump with aluminum bronze gears having three times the life of ordinary gears. The water is pumped first to the cooling header on the side of the cylinder block, where it functions to cool the oil, and out holes that are provided to inject the water under pressure in the cylinder block between the cylinders. The water then passes up through internal passages, protected by brass ferrules set in cork (to prevent electrolysis) to the cylinder head, which is provided with more than ordinary cooling capacity.

The inlet and the exhaust manifolds are integral, the exhaust being water jacketed; by this arrangement hot spots are provided just above the carburetors, correctly gasifying the fuel.

The ignition can be provided for either 12 or 32 volts and consists of 4 distributors each firing 4 spark plugs per cylinder. All the plugs are in action, but in the event of one or more systems being down, the remainder would operate the engine. This system gives the hotest spark for starting, and under actual marine experience, is the most dependable and efficient devised.

The fuel efficiency, on three-quarter to full load conditions, is .65 pounds per brake horsepower per hour. Three carburetors are used for the six cylinder engine and four for the eight cylinder engine. These are carefully tuned at the Sterling factory for maximum power and economy and should never be touched afterwards.

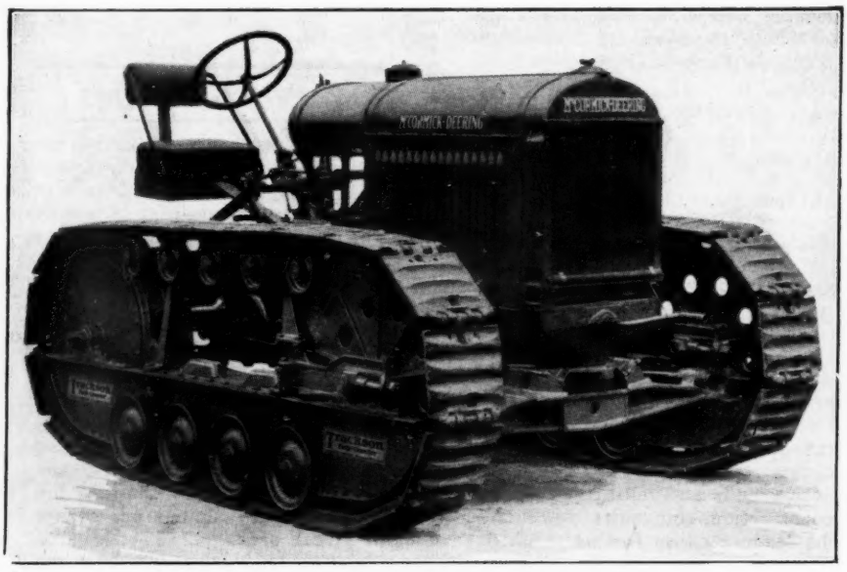
### TRACKSON-McCORMICK-DEERING

The Trackson Co., Milwaukee, Wisc., has brought out a new crawler 3½ ton power units which combines the 10-20 McCormick Deering tractor and the Trackson Full Crawler. The combination of these two tested units, it is claimed, has produced a crawler tractor especially suited to universal employment in the construction industry.

The weight of the Trackson McCormick-Deering, complete, is apapproximately 7,200 lbs.; the weight of Trackson Full-Crawlers is approximately 4,250 lbs. The over-all length with swinging drawbar is 118 inches; width, 72 inches; height, 64 inches; center to center of tracks, 60 inches; ground clearance at lowest point, 9 inches.

The ground pressure is less than 4½ lbs. per square inch. The speeds are approximately one-third of standard McCormick-Deering Industrial wheel tractor speeds.

The track is of heat-treated electric alloy steel castings 12 inches wide, self-aligning on sprockets and of non-clogging design, with corrugated ground-gripping tread which will not cut or mar streets, roads or pavements. Manganese steel tracks can be supplied for use in gritty, cutting, or abrasive soils. Special alloy steel tracks equipped with rubber pads can be supplied where the tractor is to be used on smooth, hard surfaces which would give little or no traction to the standard corrugated tracks.



TRACKSON-McCORMICK-DEERING CRAWLER

EXPERIMENT
7-G-24
DEVELOPEMENT REPORT
PURPOSE
To develop durable surface, utilizing sandy Gravel.
DATE STARTED June 14,1924
COMPLETED Oct.17,1925
MATERIALS USED
"Tarvia-B" 13-18, "Tarvia-B" 18-25.
WHERE
Tompson Road, Northchester County, E from Thornton Bridge.
METHODS EMPLOYED
Double application 13-18 "B" on bladed road surface.
Section 1 - without covering on first application.
Section 2 - sanded 8 lbs. to square yard, 1/4 gal. on each application. Second application in each instance covered with 14 lbs. to square yard of bank run gravel taken from local pit.
Sections 3 and 4 - experiment repeated with 18-25 "Tarvia-B".
Sections 5 and 6 - road surface treated with 1/4 gal. 13-18 "Tarvia-B" covered with 40 lbs. per square yard local gravel, over which was immediately .33 gal. per "Tarvia-B" 18-25.
RESULTS OBTAINED

# Make these records your information file—

FOR over twenty years Tarvia field men have "sat in" with the highway engineers and road officials of the country when plans were up—and have assisted in the actual execution of the work.

Over twenty years of experience reported—recorded—and filed.

. . . and this valuable data is at your disposal through the Tarvia field man.

The Barrett Company

| | | | | | |
|---|---|---|---|---|---|
| New York | Chicago | Minneapolis | Cleveland | Philadelphia | Boston |
| St. Louis | Salt Lake City | Baltimore | Toledo | Cincinnati | Bethlehem |
| Detroit | Milwaukee | Providence | Buffalo | Birmingham | Kansas City |
| Youngstown | Syracuse | Rochester | Columbus | Lebanon | |

In Canada

THE BARRETT COMPANY, Limited, Montreal, Toronto, Winnipeg, Vancouver

The truck wheel bearings are dirt-proof, ring-oiling bearings with large steel truck wheels fitted on tapered ends of hardened and ground alloy steel shafts. The traction surface provides 1,647 square inches of contact with ground.

The Brakes are controlled through the regular steering handwheel. They are heavy-duty, hydraulic compressed, with copper-inserted, asbestos brake linings. The brake drum diameter is 16 inches.

Grouters can be supplied for the track shoes where it is necessary to work in mud, deep sand, snow, or loose, soft ground. The grouters are very sharp, cut deep into the ground surface and increase traction tremendously. They are recommended only for conditions which necessitate extra traction. A power take-off can be used without any interference with the crawler.

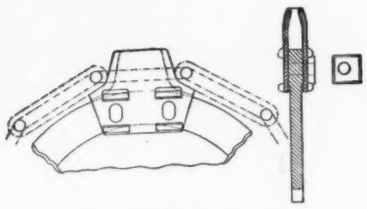
### LIGHTWEIGHT CUTTING AND WELDING TORCH

The Alexander Milburn Company, Baltimore, Maryland, has recently developed a new lightweight torch which cuts or welds with the mere interchange of tips. It is made to operate with either oxygen and acetylene, oxygen and hydrogen or other gases. This torch, known as the Type RI, has the salient features of the Milburn combination cutting and welding torch, Type NI. The Type RI torch is extremely light in weight for the wide range of work it performs, weighing only 40 ounces. This weight is advantageous to the operator for continuous work. The torch cuts or welds light or heavy metals, cutting upwards of 12 inches in thickness.

### NEW UNION EXPANSIBLE TOOTH SPROCKET

The Union Chain & Mfg. Co., Sandusky, Ohio, has developed a specially designed expansible chain sprocket, the teeth of which may be adjusted from time to time to accommodate the natural wear and consequent elongation of the links of a chain. This elongation, though seemingly slight in any one link, is multiplied by the number of links in engagement with the sprocket, causing a misfit between chain and sprocket and a consequent jerky and noisy action; this shortens the life of both chain and sprockets and more or less power is wasted.

After the chain has elongated beyond a proper fit on the sprocket, the nuts may be released and the eccentric blocks readjusted so as to expand the teeth to a next larger pitch diameter. This is usually required only at long intervals, the wear and consequent elongation of the chain being greatly retarded by maintaining its proper fit on the sprocket. Extra thick lock washers under the nuts prevent parts from working loose. The alloy steel teeth, which may wear out



UNION EXPANSIBLE TOOTH SPROCKET

after long service, are replaceable with new teeth. The four distinct advantages claimed to result from the use of this sprocket are constant maximum efficiency, longer chain lift, smoother and quieter running, and permanent sprocket installation.

### TRACKSON LOADERS AND SHOVELS

The Trackson Co., Milwaukee, Wisc., announces the addition of a line of Trackson loaders and shovels to its present line of Trackson Fuel-Crawlers. The shovel, with a 3½-foot lift, has an almost unlimited field of activity, replacing from 4 to 10 men and as many as four teams on excavating jobs, building grades, sub-grading, filling ditches and bridge approaches, digging trenches, etc. The Trackson shovel is also an efficient backfiller or bulldozer. It maly be used for leveling or pushing materials over embankments, and will handle from 80 to 160 yards per day, replacing hand labor entirely.

The high-lift loader with a 7-foot lift will load a truck or wagon in a few minutes' time. It is the ideal equipment for contractors, quarries, coal yards, industrial plants, waterworks and garbage departments, etc. The Trackson buckets are adapted to mounting on either wheel or crawler-equipped Fordsons, but for work in difficult ground conditions, such as soft, loose soil, mud or swamp, sand, gravel, snow and clay, Trackson Full-Crawlers should be used.

### STEEL TUNNEL LINERS

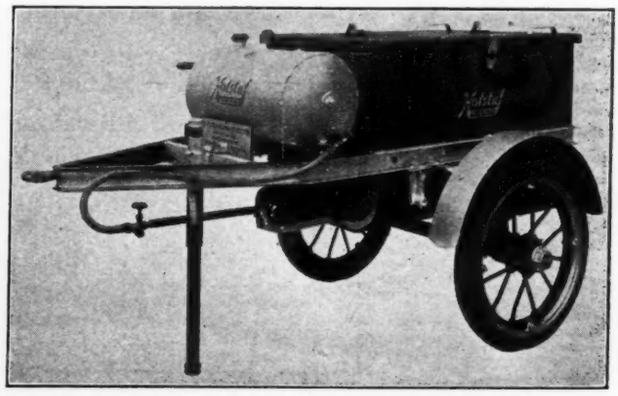
The Commercial Shearing and Stamping Co., Youngstown, O., manufactures the Commercial steel tunnel liners, which are made from any weight of steel from 12-gauge to 5/16 inch. They offer a quick and simple method of supporting roofs, sides and floors of tunnels, providing ample supporting strength, and eliminating the necessity for timbering. Plates are bolted together, beginning at the top, and supported by jacks or cross-beams. Heavy strengthening ribs are cold pressed in the face of each plate. The solid square corners and smooth flanges form tight joints that prevent seepage. Elongated bolt holes facilitate erection. A large saving in excavation and in concrete is claimed over the use of wood.

### NEW "HOTSTUF" HEATER

The Mohawk Asphalt Heater Co., Schenectady, N. Y., has just brought out a new trailer model "Hotstuf" heater, which, it is claimed, has greater heating capacity rather than storage. The new heater is equipped with Firestone cushion tires especially compounded to withstand high temperatures and protected by heat guards, and is mounted on a channel iron frame, on springs, with roller bearing wheels and an extra heavy hollow iron axle.

A special feature is the patented elevated melting chamber that produces an immediate and continuous flow of asphalt. The 8-hour melting capacity of the No. 25 is 2,500 pounds; of the No. 50, 5,000 pounds; of the No. 75, 6,500 pounds, and of the No. 100, ranges from 25 to 100 gallons. The oil storage tank capacity ranges from 15 to 20 gallons.

TRACKSON LOW-LIFT SHOVEL



NEW "HOTSTUFF" TRAILER MODEL ASPHALT HEATER

# Know Sullivan Air Lift!

Water Flow from Sullivan Air Lift Well at Oscola, Fla.

*Why not profit by the experience of others, in solving your water problems?*

Many waterworks men who knew air lift fifteen or twenty years ago—are unfamiliar with the important developments of this well pumping system.

Today's Sullivan Air Lift is as unlike the air lift systems of the past—as today's aeroplane is unlike the flying machine of 1910. All parts are engineered to work in harmony—to get the most water with the least air—and to make water supply dependable anywhere.

Whatever your well problem, consider Sullivan Air Lift.

## Shallow Wells Made Permanent

Only a short time ago, shallow wells in sand were unreliable. A brief period of pumping was followed by "slowing up" and finally complete stoppage of the well. But now, Sullivan Air Lift, by means of the "Air Made" Well, has removed this difficulty.

Scores of "Air Made" Wells have already been constructed—and in every instance the production from these wells is steadily growing.

## Trouble-Free Well Pumping

With no moving parts in the well, Sullivan Air Lift can keep wells in operation more easily than other pumping systems. You have no inspecting or repairing of the equipment deep in the well. You have no working barrels or sucker rods to pull. You have no trouble from mud or sand, crooked wells, or varying water levels—and the deeper the well, the more important these advantages become.

## Automatic Plants

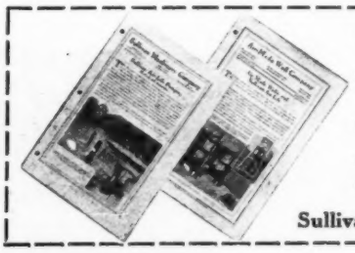
Or you may want an automatically controlled pumping system; and here again Sullivan Air Lift can serve you.

## Low Cost for Water

The trouble-free character of modern Sullivan Air Lift installations, the economy of Sullivan Air Compressors, and the experienced engineering that goes into the plant—all work together to give you a low cost per 1000 g.p.m. Tell us about your water supply troubles. We can tell you how other people have met the same troubles and how they have gotten rid of them. *Send for the latest Sullivan Booklets.*

## USE THIS COUPON

**Sullivan Machinery Company**
**138 S. Michigan Avenue**
**Chicago**



**Send the free booklets checked below:**

☐ **Sullivan Air Lift Handbook**
☐ **Air Made Wells**

**NAME** .....
**ADDRESS** .....
**OCCUPATION** .....

**Sullivan Machinery Co., 138 S. Michigan Ave., Chicago**

# SULLIVAN

TRADE MARK

BOSTON NEW YORK CLEVELAND PITTSBURGH ST. LOUIS KNOXVILLE BIRMINGHAM DALLAS DULUTH
DENVER SPOKANE EL PASO SAN FRANCISCO SALT LAKE CITY

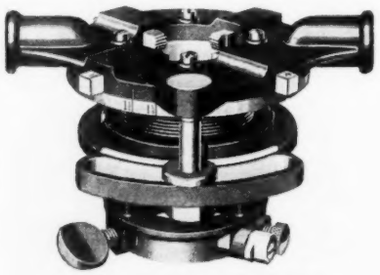
### MANHOLE AND CATCH BASIN FRAMES AND COVERS

John Root Castings Co., Chicago, Ill., manufactures a manhole and catch basin frame and cover which wedges firmly in a central position, and remains tightly seated and locked, thereby making the cover practically an integral part of the frame. It has no tendency to become loosened from the frame by traffic, preventing accidents and vibration and rattle. Due to elimination of motion, wear is reduced, and the possibility of breakage lessened. The covers cannot be removed readily from the frame except by the use of a proper tool, thus preventing accidents due to tampering with or opening covers by children. In addition to safety and longer life, the complete elimination of noise is claimed to be a sufficient reason for the use of these frames and covers.

### MONIGHAN WALKING DRAGLINE EXCAVATOR

The Monighan Machine Co., Chicago, Ill.. manufactures the Monighan dragline excavator, which has a walking traction device entirely different than that employed by other machines. The exclusive features which result from this walking traction are:

First, the base on which the machine is supported while digging is entirely independent of the traction treads and its area is so great that the bearing pressure is only about 6 lbs. per sq. in.; second, the walking platform treads are raised above the ground, and thus cannot mire while the machine is excavating. The treads are placed on fresh, untrodden ground when ready for a move; third, the direction of travel is governed entirely by the turntable swinging mechanism, which in reality is the steering device. The Monighan Walker can side-step or make short angular turns instead of making long circular turns; and can excavate cuts wider than its boom length, when depositing spoil to one side only; fourth, the Monighan walking traction device is simple in construction. The rigid treads, in one unit, do not rotate or crawl. There is little wear on the traction treads and there are no rotating or moving parts.



BEAVER DIE STOCKS

The Monighan Walker is especially suited for digging wide cuts or reservoirs, for stripping and loading at mines, quarries and gravel pits; and for digging drainage ditches and canals in marshes where the ground is very soft; also for building levees and railroad embankments, ditches and canals and miscellaneous material handling where big capacity, frequent moving, sharp turning and ability to operate over rough, hilly country are desirable.

Monighan Walking Draglines are made in various sizes from 1 cubic yard up to 8 cubic yards capacity with booms of various lengths up to 150 feet long.

### BEAVER DIE STOCKS

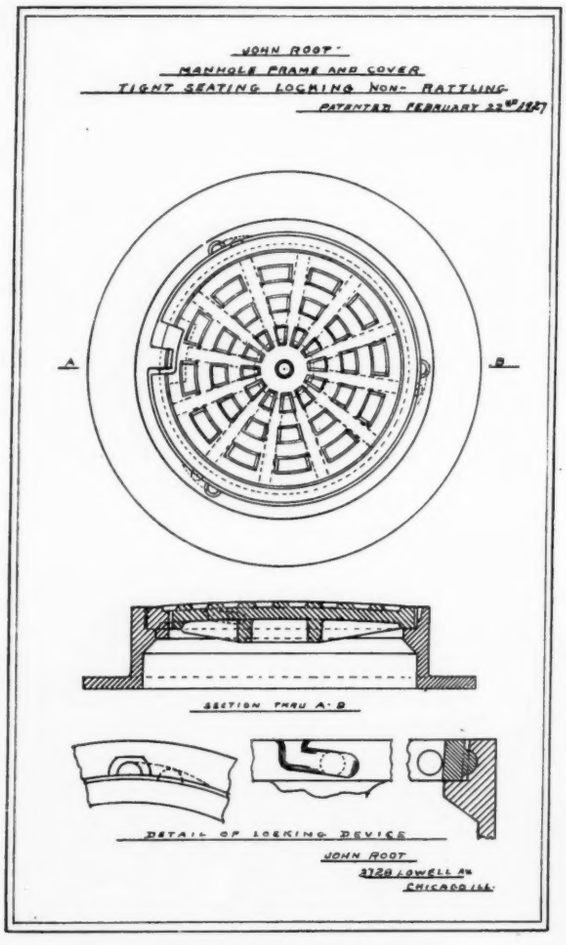
The Borden Company, Warren, Ohio, manufacturers of die stocks, pipe cutters and power drives, announces two new self-contained and adjustable 1 to 2-inch die stocks, No. 11 Beaver Plain tool, and No. 11A Beaver Ratchet.

In these new Beavers one set of dies is quickly set to thread 1, 1¼, 1½ or 2-inch without changing dies. The dies cannot become lost or mislaid because they are always in the tool ready to use. Dies are quickly adjusted to thread under or over standard without affecting the length of the thread. Either No. 11 or 11A cuts perfect threads on any kind of pipe. No special dies are needed for brass pipe. The threading dies in these new tools are made of high-grade alloy steel, specially treated with respect to hardening and tempering, and thus give much longer threading life. The die head and threaded barrel are two separate parts, so that when repairs are required only one part need be bought.

### IMPROVED MATERIAL TOWER

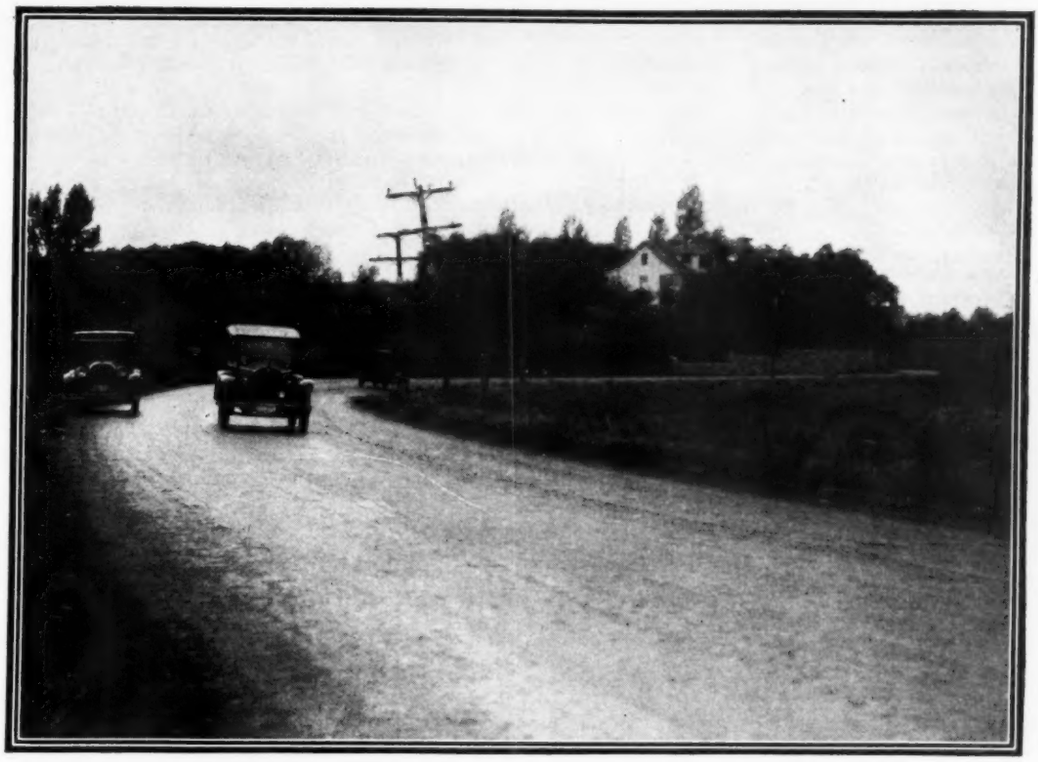
The Lakewood Engineering Company, Cleveland, Ohio, has developed a new pipe material tower which introduces a method for eliminating nuts and completely protecting bolt threads from the weather. Cages are built in two sizes, one for two wheelbarrows and one for three wheelbarrows. An elevator bucket can be used for handling concrete on the material elevator cage when desired.

Lakewood Material Towers have six fewer loose pieces for every 6 ft. 6 in. of tower, than any other tower, require two less bolts, no nuts and have all intermediate section bolt threads protected from the weather. These features insure easier erection and dismantling and greater salvage and easier warehousing, it is claimed. Standard towers can be built to a height of 300 ft. either single or double




ROOT MANHOLE COVER

MONIGHAN WALKING DRAGLINE



MINNESOTA STATE HIGHWAY No. 12

*treated with*

# *Standard Asphalt Road Oil*

Best results on first treatment are obtained by using ½ to 1 gallon of Standard Asphalt Road Oil No. 4 per square yard, varying the amount as the soil may demand.

For covering use 200 to 300 cubic yards of ½ inch gravel per mile for a 24 foot roadway.

Use a blade grader to uniformly spread the gravel covering and continue patroling with grader until the surface of the road is seasoned by traffic.

*For further information write one of the following offices:*

## STANDARD OIL COMPANY

(INDIANA)

***General Offices:*** **910 S. Michigan Ave. CHICAGO, ILLINOIS**

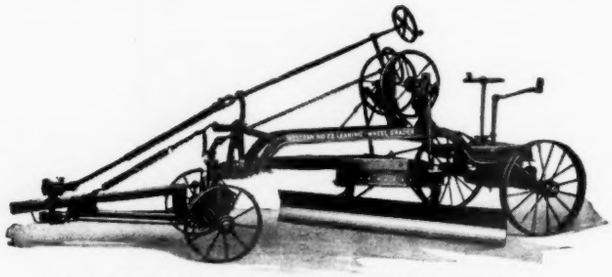
| ILLINOIS | INDIANA | IOWA | WISCONSIN | S. DAKOTA | MINNESOTA | MISSOURI |
|---|---|---|---|---|---|---|
| Chicago | Evansville | Davenport | La Crosse | Huron | Duluth | Kansas City |
| Decatur | Indianapolis | Des Moines | Milwaukee | MICHIGAN | Mankato | St. Joseph |
| Joliet | South Bend | Mason City | Green Bay | Detroit | Minneapolis | St. Louis |
| Peoria | KANSAS | Sioux City | N. DAKOTA | Grand Rapids | | |
| Quincy | Wichita | | Minot Fargo | Saginaw | | |

206

cage and can be increased in height to 400 ft. by the addition of 100 feet of extra heavy section. Figures taken from actual jobs indicate that the single cage towers can be erected at a cost of one-half man-hour per foot and the double towers at a cost of one man-hour per foot, with fairly efficient labor.

### THE NEW WESTERN NO. 22 LEANING WHEEL GRADER

The Austin-Western Road Machinery Co., Chicago, Ill., has recently brought out three new road graders.



NO. 22 WESTERN LEANING WHEEL GRADER

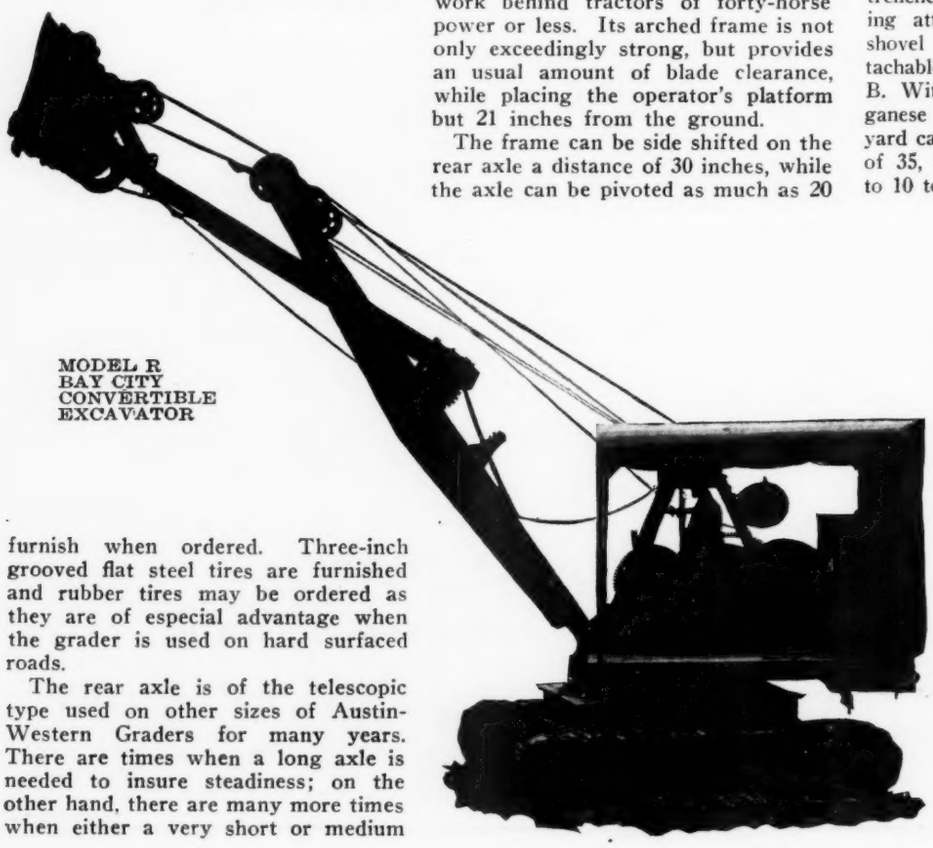
A distinct innovation is seen in the new Western No. 22 Leaning Wheel Grader. This is the first patrol grader to be built with leaning wheels and telescopic rear axle. Its design and construction makes it suitable for light grading and ditching as well as for patrol maintenance. It has an 8-foot blade.

The wheels are regularly fitted with plain bearings, but the manufacturers recommend Timken Tapered Roller bearings, which they are prepared to furnish when ordered. Three-inch grooved flat steel tires are furnished and rubber tires may be ordered as they are of especial advantage when the grader is used on hard surfaced roads.

The rear axle is of the telescopic type used on other sizes of Austin-Western Graders for many years. There are times when a long axle is needed to insure steadiness; on the other hand, there are many more times when either a very short or medium length axle is necessary, or at least exceedingly desirable; and this axle can be made short, long or medium, as the work demands.

Each rear wheel can be extended 11 inches from the closed position, and as the two wheels have separate controls, it is possible to work with both of them pulled in, with both fully extended, or with one pulled in and the other extended, the latter being a very useful adjustment when making second cuts.

Six horses can handle this grader very well, though it can be used behind a light tractor. Either the horse tongue or the steerable engine hitch can be furnished. The Western No. 22 Leaning Wheel Grader weighs 2,200 lbs. with the horse hitch and 2,500 lbs. with engine hitch.



MODEL R
BAY CITY
CONVERTIBLE
EXCAVATOR

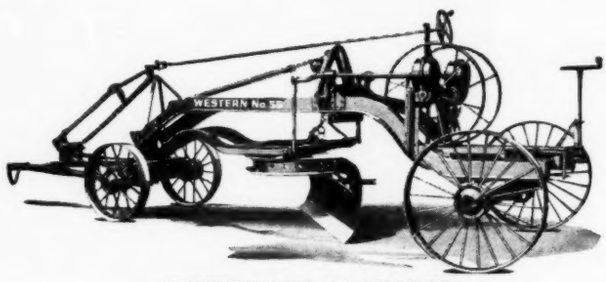
### THE NEW WESTERN NO. 55 GRADER

The Austin-Western Road Machinery Co., Chicago, Ill., has recently brought out three new road graders. The heaviest of these is the No. 55, which is a heavy duty grader built to work behind tractors of forty-horse power or less. Its arched frame is not only exceedingly strong, but provides an usual amount of blade clearance, while placing the operator's platform but 21 inches from the ground.

The frame can be side shifted on the rear axle a distance of 30 inches, while the axle can be pivoted as much as 20 degrees to resist the side pressure of the dirt on the blade, and hold the rear end of the machine to a straight course at all times.

Both front and rear wheels have 6-inch concave tires. The front wheels are 34 inches in diameter and the rear wheels 44 inches. Spokes are riveted to the hubs and tires, will never work loose, or crystallize and break off.

The No. 55 is regularly fitted with Timken Tapered Roller Bearings in all four wheels, a feature that is bound to appeal to experienced grader men. The blade raising worms and worm gears are cut steel, and run in baths of grease in dust proof housings. A powerful adjustable blade raising spring enables the operator to raise the unusually heavy blade assembly with practically no effort. The Western No. 55 Grader weighs 5,500 lbs.



WESTERN NO. 55 GRADER

### BAY CITY MODEL R CONVERTIBLE EXCAVATOR

The Bay City Dredge Works, Bay City, Mich., has announced the Model R, ¾-yard convertible shovel, crane or trencher. It is available with the following attachments: A. Standard ¾-yard shovel dipper with manganese steel detachable and reversible teeth and hinges; B. With heavy Missabe type, all manganese rock dipper, reversible teeth, ⅝-yard capacity; C. Crane boom in lengths of 35, 40 or 45 feet to handle loads up to 10 tons (at 12-foot radius) and crane buckets ranging from ½ to 1 cubic yard clamshells, and ¾ to 1 cubic yard draglines; D. Trench boom and scoop with trencher buckets ranging from 18 to 42 inches in width with a maximum digging depth of 20 feet.

It is full crawler mounted, with tread rollers enclosed on top and both sides to keep out dirt; it is one-man operated, compact in design and powered with either gasoline or electric equipment. It does not differ radically from standard design, but the following are worthy of notice: A. Compact machinery arrangement, with distance from base of boom to king-pin of 30 inches; B. Improved crawler steering mechanism; C. Short tail swing; D. Unusual stability; E. Easy lubrication. Approximate weight is 26 tons.

# TRUSCON STEEL CO CURB BARS

These specially rolled steel sections with their thick protecting faces are placed in the curb forms before concrete is poured and so become an integral part of the construction. They give to the curb a wear-proof, shockproof nose that is permanent assurance against cracking and chipping. Furnished in standard lengths of 8 feet, 10 feet and 12 feet and supplied bent to radius for corners.

## The Complete Line of Truscon Products *for* Better Roads and Pavements

WELDED STEEL FABRIC *for* Permanence and Economy.
DOWEL CONTRACTION JOINTS *for* Eliminating Cracks.
STEEL ROAD FORMS *for* Accurate Construction.
RIB BARS *for* Supplementary Reinforcing.
CURB BARS *for* Protecting Curbs.

*Our 184 page illustrated Hand Book "Modern Road Construction" free to Engineers and Contractors.*

TRUSCON STEEL COMPANY, YOUNGSTOWN, OHIO

### PORTABLE LIGHTING UNIT

The Oxweld Acetylene Company, 30 East 42nd Stret, New York has added a portable acetylene flare light to its line. This flare light is extremely powerful and is claimed to have many outstanding advantages as a portable lighting unit. The fuel used is acetylene, produced from Carbic, in the form of cakes of uniform size and cylindrical shape. Several cakes of Carbic, enough to operate the flare continuously for 12 hours, can be placed in the light at one charging. If the use of the light is discontinued before the entire charge is used, the portion remaining can be left in the holder, or, being dry, solid and clean, can be slipped back into the drum for later use. The operating cost of this light per hour of service is very low. This flare light is said to operate equally well under all climatic and weather conditions. It is equipped with a storm-proof burner, permitting its use even in the most violent gales.

CARBIC LIGHTING UNIT

There are but three parts, and these cannot be incorrectly assembled. Charging is a one-man job which requires only a few minutes. When the light has been put in operation it needs no further attention until the charge is exhausted. An automatic feed allows water to come into contact with the lowest cake of Carbic until sufficient acetylene is generated to drive the water out of the gass bell to a level below the bottom of the cake. Gas generation is uniformly and safely maintained at a pressure of less than 1 lb. per sq. in. In case the light is accidentally upset, the water runs out of the container and gas generation stops immediately.

The Carbic is available in several styles, each of which is entirely self-contained. The range in size from the 8,000 candle-power "Standard" model, which weighs 36 lb. empty and 115 lb. charged and stands 6ft. 7 in. high with reflector raised, to a hand light. A double burner model, which will furnish illumination in two directions simultaneously, is furnished in about the same size as the "Standard" model.

### THE PIONEER TRENCHER

The Cleveland Trencher Co., Cleveland, O., manufactures the Pioneer trencher, which is equipped with the "Pivot Conveyor," which allows the discharge of the dirt from the trench into a truck, or places it at any desired point, close to or away from the truck. This obviates the necessity of rehandling the dirt, affording unusual economy in many instances. This machine is unusually compact and works easily in restricted quarters. It weighs less than 7 tons, and digs to a depth of 10 feet. The pivot conveyor swings through an arc of 180 degrees. The extreme width is 4 feet 10 inches, and the cutting speed 3/8 to 8 feet per minute. Full crawler equipment is standard.

### BITUMINOUS DISTRIBUTION CHART

Hargrave Construction Co., Cedar Rapids, Ia., has devised a bituminous distribution chart which gives instantly and accurately the distance in linear feet, or the square yards covered by any quantity of bitumen in the tank, from 100 gallons to 1200 gallons, with a specified quantity per square yard, per linear foot or per mile, with a definite spray-bar width.

The chart is figured for quantities of from 100 gallons to 1200 gallons in the tank, with spray-bar widths from 4 feet to 20 feet and quantities per square yard from 1/10 to 2 gallons, and by turning to the desired chart the distance to be covered in linear feet or square yards can be determined.

It is claimed that advantages are: It dispenses with tedious calculations on the job; the correct distances and yardage can be determined before and not after the material has been applied, thus avoiding inaccurate application; by working the table backwards, the amount of bitumen required to cover a specified distance or area can be determined.

### TWIN CITY ROAD BUILDERS

The Minneapolis Steel and Machinery Co., Minneapolis, Minn., manufactures the "Road King" and the "Road Chief," road building power units.

The "Road Chief," officially rated at 17 horse power at the drawbar, is claimed to be an ideal power unit for maintaining roads. Its high speed of three miles per hour makes possible thirty miles of travel per day of ten hours. Its low speed of 2¼ miles per hour is practical for grader work in heavy cutting. These are the standard speeds. Where higher speed is desired for maintenance work, this tractor can be furnished with a high speed of 4½ miles per hour. The low speed is used for cutting earth and the high speed to move it to the middle of the road. It is equipped with wheels eighteen inches wide which give ample traction without the use of cleats under ordinary road maintaining conditions. Where maintenance forms a large part of the season's work, this machine is recommended by the makers as the best size with which to get the work done at minimum expense.

The "Road King," officially rated at 27 horse power at the drawbar, is designed as a power unit for a ten-foot blade grader. Because of its speed, it is very economical for dragging and maintaining roads. Its low speed is 2¼ miles per hour. Its standard high speed is 3 miles per hour, but it can be furnished with 4 mile speed. The "Road King" is equipped with special drive wheels 28 inches wide, which give ample traction for maintenance without the use of cleats.

### WOOD HYDRAULIC HOIST ON FORD TRUCK

The Wood Hydraulic Hoist & Body Co., Detroit, Mich., announce that the Model AA Ford chassis may now be had equipped with a power operated hydraulic hoist. The hoist used is the new G-1 type, which dumps its load in from four to six seconds, with a dumping angle of sixty degrees. Mounting height is exceptionally low and short overhang of body back of hinge provides for maximum ground clearance, allowing free discharge of load when dumping.

With the G-1 hi-speed hoist the type C-4 steel dump body, the type C28 steel garbage body, the J-1 all-purpose body or the type C-Special coal body may be used, thus allowing the prospective purchaser a wide range of power operated dump equipment, where only hand operated and gravity dumpers were heretofore available. Contractors, coal dealers, road builders and many others will find this dump unit convenient in handling, and economical in operation for pay loads up to two cubic yards..

WOOD HYDRAULIC HOIST ON FORD AA TRUCK